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# A One Hundred-Ton Mexican Wrecking Crane

The accompanying illustration shows a powerful 100-ton self-propelling wrecking crane with steam shovel attachment recently designed and constructed for the Ferrocarril Mexicano.

This Mexican railway crane with steam shovel attachment is utilized on a single track road running through a mountainous country, where extensive cave-ins and land slides are frequent. Owing to the wide radius of the shovel, it is very desirable for single track emergency use, as it can dig straight ahead and deposit in a car to the rear.

The machine is of a very heavy construction and has a main hoist with a capacity of 100 tons and also an auxiliary hoist with a capacity of 25 tons. The change from a wrecking crane to a steam shovel can be made very quickly, the boom being fastened to the rotating base and side housings by a shaft which is held in place by cotter pins. One boom is disconnected and the other substituted by simply taking out the shaft. The rotating base is a single open hearth steel casting, which supports the machinery and a structural platform on each side of the crane, the platform allowing the operator to reach any part of the machinery without leaving the cab. All operations inclusive of the firing and attendance to the boiler are controlled by one man from the elevated platform. All levers and handles are so arranged that the operator has a full and unobstructed view of the field at all times.

There is a large ring of open hearth steel which forms a face for the rollers between the rotating base and the car body. This ring has external gear teeth into which the rotating pinion meshes. Twenty-four conical steel rollers form a live supporting ring between the traveling base and the rotating structure. These rollers are bronze bushed and are centered by steel rods passing through them. The rods are connected by bands at the rollers and unite at the center-pin, where they are held in position by a ring plate. Any of the above mentioned conical rollers can be taken from its station, without dismanteling any of the machinery.

The main hoist drum is driven by the engines through the intermediate shaft and idler shaft by a positive jaw clutch and a train of spur gears. The load can be lowered against steam pressure. The auxiliary hoist consists of a drum driven by a clutch and a train of spur gears. Suspending and lowering is effected the same way as in the main hoist.

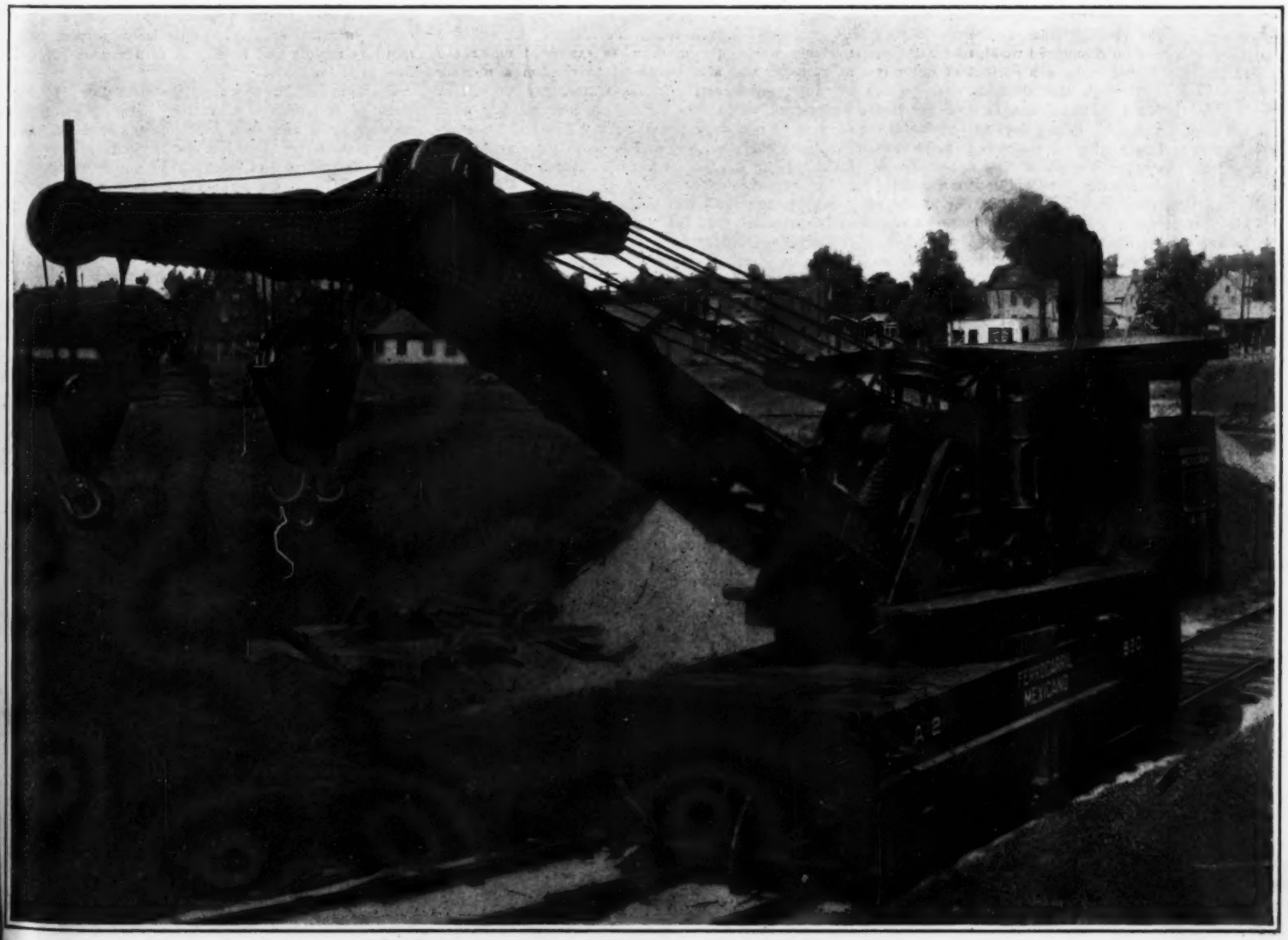
The side-bearing wedges of steel castings, operated by a handle, are pulled out, transmitting the side-bearing pressure directly to the arch bar frames, when the crane is in operation. When the crane is in transit, these wedges are pushed inward to take the pressure of the load from the body bolster and transmit it to the truck bolster springs. The truck is fitted with center and end outriggers.

The propelling mechanism can be disconnected immediately by means of a jaw clutch when it is necessary to run the wrecker in a train. In heaving up the steam-shovel attachment, the hoisting line for the dipper is connected to the auxiliary hoist drum, which gives it a faster operation. The wrecker is equipped with a pair of link reverse motion engines and a vertical tube boiler. The boiler has 117 22-inch tubes that are connected to the crown sheet by rolling and heading over copper ferrules.

The gears and pinions of this crane are of open-hearth or forged steel with steel cut teeth, except the slow running propelling and the roller ring gears. The shafts are of forged steel run in bronze bushed bearings.

It will be seen that the truck is mounted on eight wheels 33 inches in diameter. The width of the car frame and rotating frame is 9 feet 6 inches and the maximum height above the rail is 15 feet, while the length of the boom is 28 feet over all.

The capacity of the main hoist with all outriggers, is 100 tons at 17 feet radius and 70 tons at 20 feet radius. The auxiliary hoist has a maximum capacity of 25 tons at 25 feet radius and 15 tons at 15 feet radius. The speed of operation of this crane, without load, is as follows: Main hoist 10 feet per minute; auxiliary hoist 50 feet per minute; rotating one revolution per minute; traveling on level track 400 feet per minute. The speed with load varies according to the conditions and the load. This wrecker was designed to travel around a curve of 75 feet radius and to climb a 5 per cent grade.




POWERFUL WRECKING CRANE ON THE MEXICAN RAILWAY

# The Purity of Natural Waters—III*

## The Influence of Aquatic Organisms, of Domestic Sewage and of Industrial Waste

By Maximilian Marsson

Concluded from Supplement No. 1888, page 150.

### ANIMAL LIFE ON STREAM BOTTOMS.

In the foregoing we have considered certain groups of organisms that live in suspension in open waters, and we should next glance upon the bed of the stream, which is not less interesting. In collecting and concentrating the plankton, a net made of very fine silk gauze is employed, but for examinations of the bottom, the solid materials must be brought to the surface by means of a suitable dredge. Such mateirals consist of sand, mud or sludge, according to the character of the stream at the time. If the dredgings consist mainly of fine and somewhat rounded grains of sand, they will usually contain a number of mollusks or shell-fish, which feed on the living plankton and also on the dead detritus. In most rivers, both large and small mollusk, are found, ranging from Unio Pictorum and other large Anadonts down to very small varieties. At shallow places the Dreissensia, or migratory mollusks, will often be noticed adhering with their byssus or silky fibers to stones and other objects. My observations on the river Spree and all of its tributaries indicate that in their free-swimming young or larval states these mollusks constitute the main part of the plankton during the spring time, and that their food then consists of the smallest particles of organic matter suspended in the water.

In places where the bottom is rather muddy, as in the Spree above and below Berlin, great quantities of aquatic Snails, particularly Paludina and Bythinia, are often obtained by dredging. These snails breath with gills like the mollusks, while other varieties that dwell in mud, such as Limnæa and Planorbæa, breathe with lungs and appear often at the surface of the water. The aquatic snails play an important part in the oecology of water by consuming decaying vegetable matter, and thus removing many products of putrefaction. They also have much significance as food for fishes, especially roach and tench. The paludina are found mostly in mud, while the Limnæa and Planorbæa prefer to stay on sunken leaves, branches, roots and trunks near the shore.

Representatives of other groups of animals, such as fresh-water sponges or Spongillæ and moss-animals or Bryozoa also grow on submerged wood, reeds, stones, etc. In the case of the sponges, a current of water is constantly sucked through the alimentary passages, which retain the food material, and is then expelled from the cloacal passage. It is a fact that spongeillæ develop most profusely where the stream is most contaminated by municipal sewage, or "by refuse of the most incredible description," according to a certain author, and that they grow in much smaller numbers in ponds of clear water. Most species of bryozoa also seem to live on organic wastes or the products of the decomposition of vegetable and animal matter. A great variety of such bryozoa was found in the dark inlet chambers of the water-works of Hamburg and Rotterdam at a time when the river water contained large quantities of organic matter derived from a profuse development of the alga called Crenothrix Polyspora. These bryozoa, along with Spongilla Fluviatiliss are often found in water mains and are sometimes called "pipe moss." I have found a thick coating of bryozoa growing on planks in the river Panke, which is strongly polluted and always carries many fungi in its current.

The sponges and moss-animals multiply by sexual propagation and develop from flagellated larvæ. In July (1909) the sponge larvæ appeared in large numbers upon the surface of the old filters of the Berlin waterworks at Tegel Lake. My numerous examinations of the plankton and bottom of European rivers show that the sponges are very wicely distributed, and in every examination that I have made of samples taken from our North-German streams, some spicules were found. These little bars constitute the framework or skeleton on which the organic substance of the sponge grows.

The relation of the mollusks, spongillæ and bryozoa to the plankton is a manifold one, since all of these organisms in their early states of development are found therein, and more expecially because in their more fully developed states they eat both the plankton and the pseudo-plankton, as well as small masses of fungi together with the adherent protozoa and nematoda, and thus contribute to the purification of the water in much higher degree than has hitherto been estimated. The horde of snails, however, that creeps over the mud and cleanses the submerged wood and stones, thrives mainly on the algæ and fungi which are first induced to grow by decaying matter, and prevents the ultimate purtefaction of these organisms by eating them.

An instance of this kind is afforded by my observations in 1902 of the streams that received the drainage waters from the various sewage farms of Berlin, and especially during the winter. It was found that after traveling a distance of only one kilometer (0.6-mile) along the course of the streams, very few traces of the large masses of fungi which were continually discharged from the main underdrains could be detected by means of the plankton net and the dredge, but it was noticed that countless representatives of the molluscan fauna were always present at this distance. These mollusks destroyed the masses of fungi that settled to the bottom, and were zealously assisted in this work by a number of species of the larger crustacea, particularly Asellus Aquaticus. A single haul of the dredge would often bring up hundreds of these creatures, young and old. If the polluted stream or brook has a rapid current, the water will be thoroughly oxygenated and thereby often lead to the profuse development of small shrimps, Gammarus fluviatilis, which likewise feed preferably on aquatic fungi and the adherent protozoa.

We thus see that, simply in the pursuit of their food, all of these minute creatures can easily perform a task which the skill of mankind has hitherto been unable to accomplish. Many experiments with aquaria have demonstrated this fact, but the proof has been greatly strengthened by my numerous studies of long stretches of rivers. Former views about the nature of river mud were rather vague and obscure, and aside from some bacteriological studies, few comprehensive investigations thereof have yet been made. It is certain, however, that without Nature's assistance, also, at the bottom of our rivers, the remaining factors of the self-purification of our waters would soon fail.

If a sample of mud brought up from the bed of a stream is placed in a glass, innumerable small grooves or channels can be seen after a few hours on its surface at the sides of the glass. On closer examination it will be seen that these grooves were formed by thin worms which live in and upon the mud. They are mostly Oligochaetæ and principally Tubificidæ. In addition to these worms the mud, when examined under the microscope, will also be found to contain a number of very minute and colorless filamentary worms, or Nematoda, which find conditions for existence even in strongly malodorous mud. They also appear occasionally in the plankton, and indicate that highly polluted mud on the bottom has been stirred up by eddies in the current.

Malodorous mud also contains many larvæ of insects, provided that the superincumbent water is not entirely destitute of oxygen. The dark-red larvæ of certain midges, especially Chironomus Plumosus, are very common in such mud, and those of the species Tanypus are also frequently found. The larvæ of our Gnats, however, are found mostly in small bodies of stagnant water. In mud containing much decaying vegetable matter the larvæ of numerous other insects will be found, such as the Ephemera, Cloediptera, Phryganea, etc., as well as the larvæ of Water-Beetles, which prey on the former kinds. All of these subsist on the microphytes and microzoa that settle to the bottom. They grow quickly and, before reaching their final development, they become the principal food supply for those species of fishes which seek their food on the bottom, especially Tench and full grown Carp. Other varieties of fish also capture these red larvæ, as I have often found the digestive organs of Sticklebacks and other species filled with them.

The innumerable worms and insect larvæ, and especially also the fishes that hunt for them, contribute vastly to the continual loosening of the mud and the transportation of its finer particles by the current, whereby these particles are subjected to further oxidation by exposure to better aerated masses of water, and are also rendered accessible for the extraction of food by all of the detritus-eaters mentioned. More or less extensive banks of mud are always formed below eddies and obstructions, but a limit to the exclusively putrefactive fermentation thereof is set by the larger fauna. These creatures are ably assisted in this work by countless representatives of the microfauna and microflora, the former consisting mostly of the typical protozoa and rotatoria of sewage, and the latter of ground diatoms along with certain fungi and algæ, chiefly Oscillatoria.

If the bottom of the stream has not been completely sterilized by injurious chemicals, its condition will not remain stationary or fixed in composition, owing to the persistent activity of its small inhabitants. The bed of the stream is therefore not merely a storage place for many kinds of sediment, but is rather a place adapted to the decomposition of all the organic matter in the sediment.

There are also bodies of water like the Black Sea in which a descending circulation is lacking, so that there is not enough dissolved oxygen at their bottoms to oxidize the organic substances; the result of this condition is that the sulphates become reduced by dissociation of oxygen to sulphides, whereby the deep strata of water are impregnated with sulphuretted hydrogen.

In shallow streams the sedimentary matter is distributed more rapidly over extensive areas of the bottom than in deep bodies of water; and in shallow ponds and lakes the wind is an efficient agent in the distribution of such matter. Certain representatives of the larger fauna, such as mollusks belonging mostly to the Dreissensia family, settle near the shores where the water is usually kept in motion and well aerated; while in sheltered coves and bays there is always a growth of aquatic plants, such as Reeds, Rushes and Sedges, between the stems of which many small aquatic animals pass their lives. In other places a submerged forest of more highly-organized water plants such as Myriophyllum, Ceratophyllum, Anacharis, etc., will be found, which teems with minute animal life and extracts, like the algæ, much organic matter and carbonic acid from the water.

In quiet coves we may also find under certain conditions a growth of filamentous algæ, especially those of the zygnemaceæ family, which often develop in enormous quantity. They are lifted to the surface of the water by the gases evolved in the process of assimilation, and are then dispersed by the wind or current; but by means of their dual mode of nutrition they are able to retain their vitality and continue their work of purification for a considerable period of time after such transportation. After death their tangled masses of filament become of the habit of innumerable minute animals, particularly worms, which multiply rapidly and furnish in turn a good supply of food to young fishes.

We thus find in our waters the most diversified relations of interchange of matter between plants and animals, or between food producers and food consumers. Among the latter there is a constant struggle for existence, the final victors being the predatory fishes which are chiefly used for human consumption, and whose food has been evolved in a complex manner from the dead organic matter originally present in the water. On their own death, their bodies become a source of nutrition for the other animals whose progenitors served to feed them. All these biological processes can be recognized and studied much more advantageously in fresh water than in the boundless ocean.

### PRACTICAL APPLICATIONS.

*Balancing Wastes and Assimilators and Consumers.*—Although the foregoing considerations have shown that our rivers and their inhabitants can readily master the natural pollutions, such as the domestic sewage of our cities and certain trade wastes, and that in many cases clean wafer is again found flowing in streams only a comparatively short distance below the point of contamination, nevertheless it is necessary to bear in mind that the quantity of putrescible and putrefying matter must always be in proper proportion to the volume of water. My observations have established the fact that the sewage of small cities and the drainage waters of sewage farms of moderate size are easily digested by relatively small streams, while, on the other hand, the insufficiently-purified liquid wastes of large isolated factories, which are usually produced in excessive quantity at a certain time in the year, as after harvest, have often caused serious damage through distances of many kilometers in relatively large streams. In such cases a severe loss results to the fisheries.

*Trade-Waste Dangers.*—Concerning the capacity of a stream to digest or purify sewage and other wastes, definite figures and limits, such as those given by Pettenkofer, cannot be made readily. The maximum quantity of such liquid that a stream can digest, depends not only on its physical characteristics, but also on its individuality in other respects. Both the biological and the chemical factors must here be taken into consideration. If the industrial wastes contain much acid, alkali or other matter that is poisonous to the animal

* Reproduced from *The Engineering News*

and plant life of a stream, entirely different conditions are presented from those which occur with domestic sewage and harmless wastes. Thus it has been found that tar products have destroyed all the animal and plant life in the mud bottom of long stretches of river, and that alkalies and acids have killed off every kind of fish by attacking the gills and thereby causing death by suffocation. With a proper quantity of harmless organic wastes, on the other hand, the microscopic organisms suspended in the water, as well as the larger flora and fauna, will labor incessantly to keep the stream in a healthy condition.

In regard to injury to fishes, the opinion has hitherto been that the numerous kinds of industrial wastes consisting of finely divided insoluble matter, such as is produced by cellulose, paper, cloth, cotton and rag mills, and also by mines and iron works, are all injurious by their tendency to lodge in the gills. Such waste matter may be either flocculent, or in the form of fine hairs or fibers, or sharp-edged hard grains. My own observations indicate in general that such is not quite the case. A healthy fish has the power to eject all such foreign bodies from its gills. If, however, the gills are irritated by only small quantities of acid, alkali, or even salts, these organs endeavor to protect themselves against the action of such chemicals by exuding a considerable quantity of mucus upon their surface; and the damage is then done by the adhesion of the particles of cellulose, textile fiber, or other matter to this mucus and the accumulation of such matter thereon, until the gills become so completely covered as to cause suffocation. A copious secretion of mucus by the gills is induced by very small amounts of such chemicals in the water. When the chemicals are present in large quantity or strongly concentrated, the gills are destroyed directly by disintegration.

If acids are discharged into a stream, a new factor for the self-purification of the water is introduced by the neutralizing capacity of the dissolved bases. Thus the bicarbonate of lime usually carried in solution in the water will neutralize a certain quantity of the acids; and in the case of sulphuric acid a combination with lime will occur, whereby the resulting insoluble sulphate of lime, or gypsum, will settle on the bottom. Such a self-purifying process, however, is not a natural one, as the acid of the sulphate in the mud is sometimes reduced by other processes to sulphuretted hydrogen. This latter is a well-known poison for fish, but it may be rendered harmless by the operations of the sulphur bacteria, such as the Beggiatoa previously mentioned.

Similarly, if caustic lime is thrown into the stream, it will ultimately be rendered harmless to fish by combining with the free carbonic acid in the water and forming either insoluble carbonate or soluble bicarbonate of lime, the latter being a normal component of many natural waters. This process, however, is not very rapid, and before its completion the water must generally flow through long distances.

OTHER FACTORS AND GENERAL CONCLUSION.

A consideration of all the remaining factors that enter into the self-purification of a stream would require much more time than is now available, and hence only the more important ones can here be indicated. They are mainly of a physical character, such as the current and the aeration of the water induced thereby; the intensity of the sunlight, and even also that of the moonlight; the more or less rapid sedimentation of the suspended mineral matter in the water; the dilution caused by rain, the inflow of ground-water, and by the various tributaries; the quality of such additions; the influences of temperature, climate and seasons, etc.

The self-purification of a stream thus involves a large number of factors, all of which stand in mutual relationship and interaction like the wheels of a clock, and the main object of the foregoing considerations was to point out the great importance of the action of animal and plant life alone in conserving the purity of our waters.

# Recent Progress in Spectroscopic Methods—II*

## Past Achievements and Future Prospects

By Prof. A. A. Michelson

Concluded from Supplement No. 1888, page 156

Enough has been said to show clearly that are modern problems are such as to tax to the utmost the powers of the best spectroscopes and the experimental skill of the most experienced investigators.

Some twenty years ago a method was devised which, though somewhat laborious and indirect, gave promise of furnishing a method of attack for all these problems far more powerful than that of the diffraction grating.

Essentially, the extremely simple apparatus which is called the *interferometer* consists of two plane glass plates. These can be made accurately parallel, and their distance apart can be varied at will. When light is reflected from the surfaces which face each other, the two reflected beams of light waves "interfere" in such a way as to add to each other, giving bright maxima, or to annul each other's effect, producing dark spaces between.

The alternations of light and darkness which occur when the eye observes in the direction of the normal are very marked so long as the plates are very near together; but as this distance increases the interferences become less and less distinct, until at a distance, *which depends on the character of the incident light*, they vanish completely. A perfectly definite relation holds between the "visibility curve" and the character of the radiation, so that the one can be deduced from the other.

Now, the "resolving power" of such an apparatus is measured by the number of light waves in the doubled distance between the surfaces. This is about 100,000 for a distance of 1 inch; but the distance is, in fact, *unlimited*, and as the instrument itself is practically free from errors of any sort, its resolving power is practically unlimited.

The use of this method of light-wave analysis is attended with certain difficulties, and the results obtained are not always free from uncertainties; but in view of the fact that at this time no other methods of this power had been devised, it has amply proved its usefulness. Among the results achieved by it may be mentioned the resolution of many lines supposed single into doublets, quadruplets, etc.; the measurement of their distances apart; the distribution of light in the components; the measurement of their width and the changes produced in them by temperature, pressure, and the presence of a magnetic field.

Among the radiations thus examined, one proved to be so nearly homogeneous that more than 200,000 interference bands could still be observed. Otherwise expressed, the exact number of light waves in a given distance, say 10 centimeters, could always be determined, and by a comparison with the standard meter the absolute wave-length of this radiation could be measured and made to serve as a basis for all wave-lengths.

The standard of length itself, the standard meter, is defined as the distance between two lines on a metal bar; and notwithstanding all the care taken in its manufacture and preservation, there is no assurance that it is not undergoing a constant slow change, doubtless very small, but perhaps appreciable by the refinements of modern metrological methods if there were any fundamental unchangeable standard with which it could be compared. The earth's circumference was supposed to be such a standard, and the meter was originally defined as the millionth part of an earth-quadrant; but the various measurements of this quadrant varied so much that the idea was abandoned. The attempt to base the standard on the length of a seconds-pendulum was no more successful.

But we have now the means of comparing the standard meter with the length of a light wave (the standard meter contains 1,553,163 waves of the red radiation from cadmium vapor), so that should the present standard be lost or destroyed, or should it vary in length in the course of years, its original value can be recovered so accurately that no microscope could detect the difference. True it is that in the course of millions of years the properties of the atoms which emit these radiations and the medium which propagates them may change, but probably by that time the human race will have lost interest in the problem.

The difficulties in the application of the interferometer method of investigating the problems of spectroscopy, it must be admitted, were so serious that it was highly desirable that other instruments should be devised in which these difficulties were avoided. This need was supplied by the "echelon," an instrument based on the same principle as the diffraction grating, but consisting of a pile of glass plates of exactly equal thickness and forming a kind of stairs, whence its name.

The grating acts by assembling light-waves the successive wave trains of which are retarded by some *small* whole number of waves (usually less than six, the distance between the grating spaces being about six light waves), whereas this retardation in the echelon is many thousand.

But the resolving power depends on the *total* retardation of the extreme rays, and this may be made very large either by having an enormous number of elements with small retardations, or by a comparatively small number of elements with large retardations. For example, an echelon of thirty plates of glass 1 inch thick, each producing a retardation of 25,000 waves, would have a resolving power of 750,000, about seven times that of the grating; and this high value has actually been realized in practice.

Simultaneously, Perot and Fabry showed that by the repeated reflections between two silvered surfaces[1] a very high resolving power is obtained, and a few years later Lummer devised the plate interferometer, which embodies practically the same idea.

The resolving power of all of these newer devices is clearly many times as great as that of the grating; but all equally share the objection which holds (but to a far less extent) for the grating—that the different succeeding spectra overlap. It is true that this difficulty may be overcome (though with some loss of simplicity and considerable loss of light) by employing auxiliary prisms, gratings, echelons, etc., and in this form all these modern instruments have contributed results of far-reaching importance, which would have been impossible with the older instruments.

The diffraction grating possesses so many advantages in simplicity and convenience of manipulation that it is even now used in preference to these modern instruments, except for such refinements as require an exceptionally high resolving power. But has the resolving power of the grating been pushed to the limit? We have seen that this depends on the number of rulings; and it is certainly possible to increase this number. But the theoretical value is only reached if the rulings are very accurately spaced; for instance, the resolving power of the Rowland grating is only one-third of its theoretical value. This is a direct consequence of inaccuracies in the spacing of the lines. If a grating could be constructed of, say, 250,000 lines with exact spacing, the resolving power would be equal to that of the most powerful echelon. The problem of the construction of such gratings has occupied my attention for some years; and while it has met with some formidable difficulties, it has had a fair measure of success, and gives promise of still better results in the near future.

The essential organ in all ruling engines in actual use is the screw, which moves the optical surface to be ruled through equal places of the order of a 500th to 1,000th of a millimeter at each stroke; and the principal difficulty in the construction of the machine is to make the screw and its mounting so accurate that the errors are small compared with a thousandth of a millimeter.

This is accomplished by a long and tedious process of grinding and testing, which is the more difficult the longer the screw. A screw long enough to rule a 2-inch grating could be prepared in a few weeks. Rowland's screw, which rules 6-inch gratings, required two years or more; and a screw which is to rule a grating 15 inches wide should be expected to take a much longer time, and, in fact, some ten years have been thus occupied.[2]

I may be permitted to state a few of the difficulties encountered in this work, some of which would doubtless have been diminished if my predecessors in the field had been more communicative.

First is the exasperating slowness of the process of grinding and testing the screw. This cannot be hurried, either by grinding at greater speed or by using any but the very finest grade of grinding material. The former would cause unequal expansions of the screw by heating, and the latter would soon wear down the threads until nothing is left of the original form.

Secondly, in ruling a large grating, which may take eight to ten days, the ruling diamond (which must be selected and mounted with great care) has to trace a furrow several miles long on a surface as hard as steel, and often breaks down when the grating is half finished. The work cannot be continued with a new diamond, and must be rejected and a new grating begun.

Thirdly, the slightest yielding or lost motion in any of the parts—screw, nut, carriage, or grating—or of the mechanism for moving the ruling diamond, is at once evidenced by a corresponding defect in the grating. When, after weeks, or sometimes months, of preparation all seems in readiness to begin ruling, the diamond point gives way, and as much time may have to be spent in trying out a new diamond.

* Address by the retiring president of the American Association for the Advancement of Science.

[1] Boulouch, 1893, had observed that Na rings were doubled both by reflection (grazing incidence) and transmission (normal incidence) with a light silver film.

[2] A method of ruling gratings accurately, which is independent of any mechanical device, is now in process of trial, in which the spacing is regulated by direct comparison with the light waves from some homogeneous source such as the red radiations of cadmium.

When the accumulation of difficulties seems to be insurmountable, a perfect grating is produced, the problem is considered solved, and the event celebrated with much rejoicing, only to find the next trial a failure. In fact, more time has been lost through such premature exhibitions of docility than in all the frank declarations of stubborn opposition!

One comes to regard the machine as having a personality—I had almost said a feminine personality—requiring humoring, coaxing, cajoling, even threatening! But finally one realizes that the personality is that of an alert and skillful player in an intricate but fascinating game who will take immediate advantage of the mistakes of his opponent, who "springs" the most disconcerting surprises, who never leaves any result to chance, but who nevertheless plays fair, in strict accordance with the rules of the game. These rules he knows, and makes no allowance if you do not. When *you* learn them, and play accordingly, the game progresses as it should.

As an illustration of the measure of success attained in this work, I would direct attention to a recent comparison by Messrs. Gale and Lemon of the performance of a grating of 6½-inch ruled surface with that of the echelon, the Perot and Fabry interferometer, etc. The test object is the green radiation from incandescent mercury vapor. The spectrum of this radiation had been supposed a simple line until the interferometer showed it to be made up of five or more components. The whole group occupies a space about one-fifteenth of that which separates the sodium lines.

The grating clearly separates six components, while the more recently devised instruments give from six to nine. Two of these components are at a distance apart of only 1/150 of the distance between the sodium lines, and these are so widely separated by the grating that it would be possible to distinguish doublets of one-half to one-third this value, so that the actual resolving power is from 300,000 to 400,000—of the same order, therefore, as that of the echelon.

It may well be asked, why is it necessary to go any further? The same question was put some twenty years ago when Rowland first astonished the scientific world with resolving powers of 100,000, and it was his belief that the width of the spectral lines themselves was so great that no further "resolution" was possible. But it has been abundantly shown that this estimate proved in error, and we now know that there are problems the solution of which depends on the use of resolving powers of at least a million, and others are in sight which will require ten million for their accurate solution, and it is safe to say that the supply will meet the demand

To return to our comparison of the telescope and the spectroscope; while the progress of investigation of the stellar universe will be ever furthered by increased size and resolving power of the telescope, this is very seriously hampered by the turbulence of the many miles of atmosphere through which the observations must be made. But there is no corresponding limit to the effective power of spectroscopes, and the solution of the corresponding problems of the subatomic structures and motions of this ultramicroscopic universe may be confidently awaited in the near future.

The messages we receive from the depth of the stellar firmament or from the electric arcs of our laboratories, come they in a millionth of a second or in hundreds of light-years, are faithful records of events of profound significance to the race. They come to us in cypher—in a language we are only beginning to understand.

Our present duty is to make it possible to receive and to record such messages. When the time comes for a Kepler and a Newton to translate them we may expect marvels which will require the utmost powers of our intellect to grasp.

# A Proposed Expedition to Crocker Land

## American Explorers to Investigate the North Polar Regions

A CIRCULAR has just been issued by the American Museum of Natural History, setting forth in brief some of the main facts of the plans for an expedition to Crocker Land, a tract located by Admiral Peary in 1906.

We reproduce here the essence of this circular, which should be read with interest by every American citizen who takes a patriotic interest in the conquest by Americans of "the last considerable mass of unknown land on our planet"—to quote the words of Col. Roosevelt in a letter to Prof. H. F. Osborn.

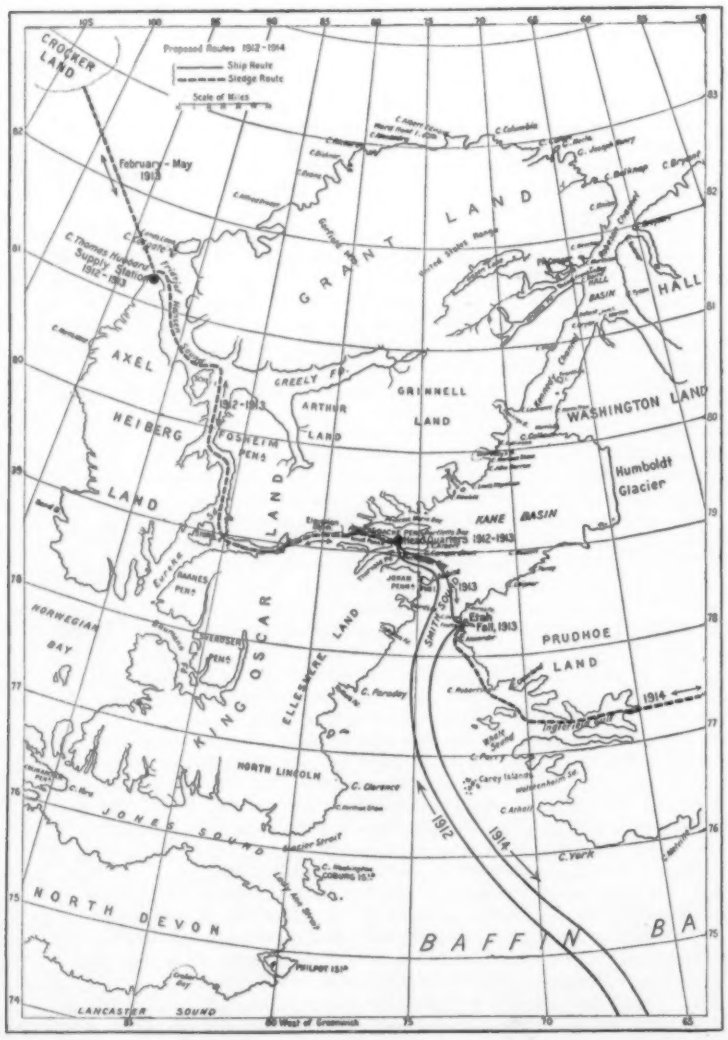
We reproduce here the essence of this circular.

CROCKER LAND.

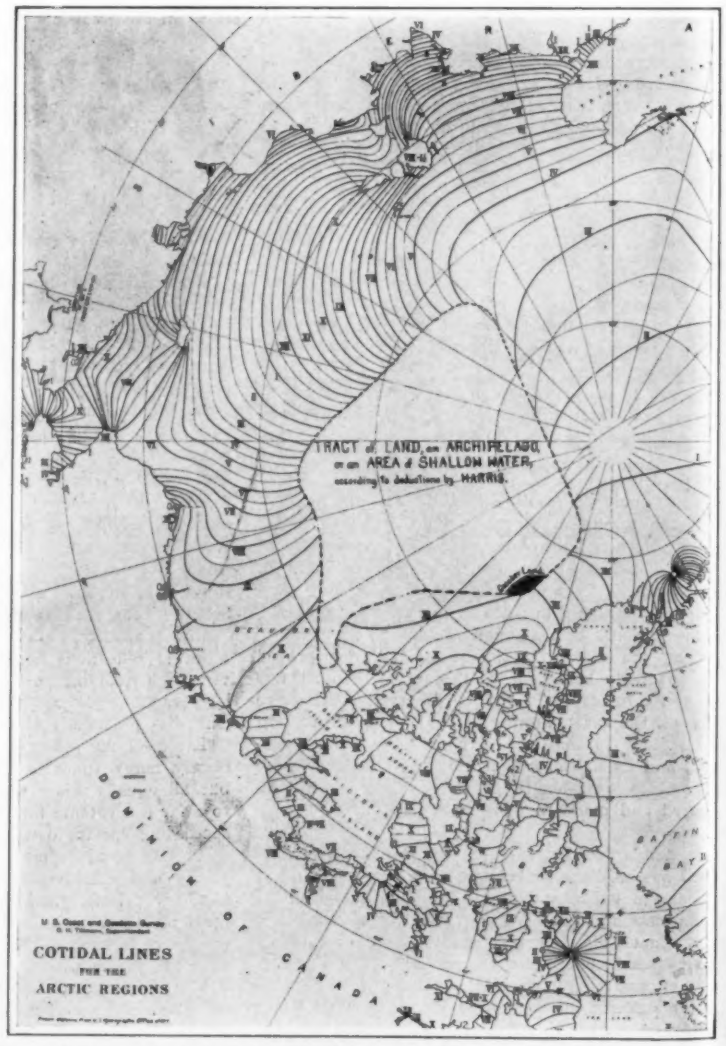
In his book "Nearest the Pole," Admiral Peary records observations made June 30th, 1906, from the summit of Cape Thomas Hubbard, the most northern point of Axel Heiberg Land, when "The clear day greatly favored my work in taking a round of angles and with the glasses I could make out, apparently a little more distinctly, the snow-clad summits of the distant land in the northwest above the ice horizon." This land had been seen a few days before by Peary and his Eskimos from the northern shore of Grant Land, and particularly from the top of Cape Colgate, 2,000 feet above sea level. Peary located the new land at about 100 degrees west longitude and 83 degrees north latitude, or about 130 miles from Cape Thomas Hubbard, and gave it the name of Crocker Land, in honor of the late Mr. George Crocker, of the Peary Arctic Club.

Dr. R. A. Harris, tidal expert of the United States Coast and Geodetic Survey, in his monograph on "Arctic Tides" (1911), published his deduction, based on a plot of all known Arctic tidal observations, that a great area of land or archipelago, or very shallow water, trapezoidal in outline and half a million square miles in superficies, exists north of western America and eastern Siberia, and stated his belief that the Crocker Land observed by Peary was part of its eastern edge.

The verification of these observations and deductions by making a sufficiently long journey northwestward from Cape Thomas Hubbard seems to be the last great geographical problem left for solution. Nansen, in an article on "North Polar Problems" (1907), says "The determination of the extent of the continental shelf to the north of Axel Heiberg Land and Ellesmere Land would be a great achievement. . . . A satisfactory solution of this problem would be of more scientific value than even the attainment of the Pole. . . . The extent and shape of the polar continental shelf, which means the real continental mass, is the great feature of north polar geography which is of much more importance, geographically or geomorphologically,




Map of a Part of the North Polar Regions, Showing Field of Operations of the Expedition.


TRACT of LAND, or ARCHIPELAGO, or an AREA of SHALLOW WATER, according to deductions by HARRIS.
COTIDAL LINES FOR THE ARCTIC REGIONS
DOMINION OF CANADA
BAFFIN BAY

Map of Arctic Regions Showing Cotidal Lines and Land Area According to Harris.

than the possible occurrence of unknown islands on this shelf."

While on the way to and from Crocker Land, soundings will be made to determine whether the continental shelf extends as far as that land or reaches beyond it.

SCIENTIFIC STUDIES.

From Flagler Bay to Cape Thomas Hubbard (some 330 miles through Ellesmere, Axel Heiberg and Grant Lands), continuous geological, paleontological and physiographic work will be done and specimens collected. From Cape Thomas Hubbard to Crocker Land, in addition to the soundings already mentioned, tidal observation, temperature observation at various depths in the water and collections of marine animals will be made. On Crocker Land, two months will be spent, mapping topographically and geologically the coast line and interior, and collecting specimens of rocks and fossils and of living plants and animals. A thorough study of glaciers, glacial ice-caps and glacial motion will be made, for the purpose of solving the problem of the process of land molding under a continuous, moving ice-cap, a process which is not yet understood. The "glacial fringe" off the north coast of Grant Land offers a particularly interesting field for study. Attention will be paid to meteorology, ethnology, archeology, birds, mammals and fishes. Arctic small mammals and fishes are conspicuous by their absence from our museum collections. No habitat group of Arctic birds has been attempted in any of our museums.

PLAN OF CAMPAIGN.

It is proposed to leave Sydney, N. S., by special steamer about July 20th, 1912, collecting whale and walrus meat and dogs on the way northward. The expedition will land on the south side of Bache Peninsula (Flagler Bay), latitude 70 degrees 10 minutes north and establish the winter quarters. The site of these will be seen at the center of one of the maps which accompany this article. The ship will be sent home. About the middle of September the explorers will begin to sledge supplies to Cape Thomas Hubbard, carrying on the work throughout the winter during the moonlight periods. With the return of dawn in February, 1913, they will leave Cape Thomas Hubbard and push across the ice to Crocker Land, where they will remain until about the first of May, returning to Cape Thomas Hubbard about that date. A messenger will be sent to North Star Bay with news of the expedition, to be forwarded to the civilized world by Danish steamer. In the meanwhile, the scientific work will be carried on in Grant Land and the winter quarters will be re-entered in July, 1913.

During the summer the supplies and collections will be transferred to Etah at points somewhat south of Bache Peninsula (see map). For the spring and summer of 1914 an expedition from Whale Sound (Inglefield Gulf), directly eastward to the summit of the ice-cap of Greenland, is planned. The return to New York is to take place in the autumn of 1914.

PERSONNEL.

The leaders of the expedition will be George Borup (A.B., Yale, 1907), Assistant Curator of Geology in the American Museum of Natural History, and Donald B. MacMillan (A.B., 1898, A.M. (Hon.), 1910, Bowdoin). They will take with them a competent physician and a cook. Messrs. Borup and MacMillan are well known to the public, both general and scientific, through their work done under Admiral Peary in his last polar expedition, Mr. Borup's book "A Tenderfoot with Peary" and Mr. MacMillan's extensive lecturing throughout the country. They have received Peary's unqualified indorsement for the work in hand. Mr. Borup has been devoting his whole attention during the past two and a half years to studies in the field and at Yale to fit himself thoroughly for scientific geological and geographical exploration. On account of his record, Mr. Borup has been elected a fellow of the Royal Geographical Society of London and a member of the New York Academy of Sciences. Mr. MacMillan, since his return from the Peary expedition, has been studying ethnology and practical astronomy at Harvard. In the summer of 1910, he was a member of the Cabot party which was the first to cross Central Labrador from the sea to George River, and he spent the summer of 1911 cruising along the coast of Labrador in an eighteen-foot open canoe studying the Eskimo from Hopedale to Killinek (60 degrees north latitude). Mr. MacMillan is a member of the American Geographical Society, the Appalachian Mountain Club, etc. He is now at the American Museum of Natural History outfitting the expedition and making special studies there and at Columbia University.

OUTFIT.

The following are some of the principal items of the outfit to be provided: three years' provisions for four or five white men, their helpers and their dogs, much of which, particularly the pemmican, has to be specially prepared and packed; clothing; instruments for all kinds of observations and records; photographic cameras, including those for moving pictures; a power boat for use in Flagler Bay and in crossing to Etah; salary of physician and wages of cook and helpers; a steamship to take the party to Flagler Bay in 1912 and another to go up for it in 1914.

COST.

It is estimated that not less than fifty thousand dollars ($50,000) should be provided for the absolute needs of the expedition, in order to enable it to accomplish the valuable results that have been outlined above.

Messrs. Borup and MacMillan generously serve the expedition without salary during the period of its absence from New York.

The funds for this expedition are to be drawn entirely from voluntary contributions subscribed by various institutions and private individuals. A considerable amount of money has at the present time been subscribed or promised, but there still remains a considerable sum to be collected to start the campaign on a sound financial footing. The museum has opened an account known as the "Crocker Land Expedition Fund," to receive and care for all subscriptions made to the expedition. Checks to further this purpose should be drawn payable to the American Museum of Natural History. A list of subscribers will be duly published and will be included in the final reports. Expenditures from the fund will be made in accordance with formalities usual at the museum.

# Friction Between Solids in Motion

## An Instrument of Precision for Accurate Investigation

### By Our Berlin Correspondent

THE mutual friction of two bodies sliding upon each other is generally complicated by the effect of particles torn off from either. In order, therefore, to investigate friction proper without any disturbing phenomena, samples should be chosen of perfectly smooth surfaces, which moreover will remain smooth after sliding over one another.

In a memoir recently presented to the French Academy of Sciences, Prof. F. Charron of Angers, France, drew attention to a peculiar phenomenon observed in this connection, which is generally masked by secondary effects; the friction co-efficient gradually decreases with increasing speeds, becoming nearly nil with what is called the *critical speed*. This decrease in friction is, it seems, due to the effect of an air layer which in the case of speeds below the critical, only partially separates the two rubbing substances, while dividing them entirely from one another at any speed equal to or exceeding the critical speed. This lubricating action of air was by the way observed by Hirn years ago, who, however, did not investigate it any further.

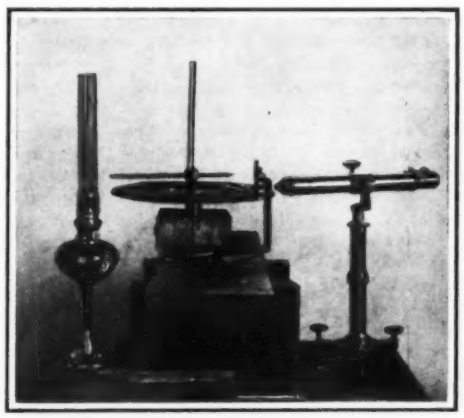
Prof. Charron uses in connection with his experiments copper, cast iron, and graphite samples, ground absolutely smooth, which slide on a carefully leveled glass plate either bare or silvered.

The apparatus represented in the illustration comprises a disk of good St. Gobain plate-glass, rotating without any play round a vertical axis, and maintained strictly in the same plane, so that the images of surrounding objects do not move as the plate revolves.

A friction block consisting of a sample of the substance to be investigated is placed on this rotating glass disk, being suspended by two thin flexible threads arranged in a triangle from some kind of scale-beam with a damping device. A scale viewed by means of mirrors through a telescope allows the motion of the balance beam to be accurately ascertained, and friction to be calculated.

Before each experiment the glass disk is carefully cleaned with alcohol, and during the test any dust and particles detached from the rubbing block are removed by a pad of wadding, sliding with slight friction on the disk.

After pointing the telescope to the zero of the scale (while the apparatus is at rest, the threads are not drawn tight), the rubbing block is loaded with a known weight, and the disk set rotating at a low speed. On



Apparatus for Experimenting on the Friction of Solid Bodies.

the cross wires of the telescope a certain division of the scale (e. g., division 20) is observed.

If, then, the speed is increased continuously, the deflection of the scale is seen to decrease, eventually becoming less than one division. In fact, the force becomes so feeble that the threads are no longer tight. The residual force still acting on the rubbing block is then ascribable to the viscosity of the air layer between it and the glass plate.

By arranging a lamp at the level of the glass disk this air layer can be observed, and its thickness measured by means of a telescope fitted with an ocular micrometer. The air layer is then found entirely to separate the block from the glass plate only when the speed equals or exceeds the critical value. The thickness of the layer is not uniform, being greater in the front than at the back. The average, which varies according to the conditions of the case, may reach some hundredths of a millimeter.

The critical speed defined by Charron varies according to the nature and the condition of the lubricant, as well as the load and the geometrical form of the rubbing block.

In the case of a graphite block 1.4 grammes in weight with a rectangular basis one square centimeter (0.155 square inch) in area, Charron finds the following critical speeds (in centimeters per second) according to the load put on the rubbing block (in grammes):

| Load. | | Critical speed. |
|---|---|---|
| 1.4 | grammes | 192 centimeters |
| 2.4 | " | 262 " |
| 3.4 | " | 290 " |
| 6.4 | " | 437 " |
| 11.4 | " | 770 " |

These figures are, however, only approximately correct because of difficulties encountered in ascertaining the speed, the more so as the electro-static attraction of the oppositely electrified rubbing bodies adds itself to the weight of the block. As air, especially in the case of small loads exerts a very considerable lubricating action, this disturbing factor should be eliminated in friction tests by working in vacuo.

To this end Charron uses a cast iron case closed with a glass cover fitting on the carefully planed edges. The glass disk rotates inside a box with leather stuffing box for the passage of the axle. The apparatus above described is arranged in the interior of the cast iron case which is closed hermetically by a glass plate lined with tallow and placed upon the planed edge, which plate allows any beams of light serving to ascertain the position of the scale beam to pass through it.

As the air in the case is exhausted, friction is found to vary less and less with increasing speeds, although even with a pressure of two to three centimeters of mercury, these variations are still very marked when the load is 4 grammes. When, however, the vacuum is driven as far as one millimeter by means of a good mercury pump, the friction co-efficient becomes very approximately constant, and independent of the speed, thus confirming the conclusion as to the part played by the air.

**Bending Wood.**—Wood may be made soft and flexible by steeping it in a concentrated solution of common table salt to which some acetate of iron has been added. A better method is to immerse the wood in a bath made by dissolving 25 parts of calcium chloride in 100 parts water. It should be left there for some time, and after bending is thrown in cold water to harden.—*Zeitschr. f. Drechsler.*

# The Building Up of an Industrial Enterprise*

## The Prime Requisites: Brawn and Brain

By Prof. John Edson Sweet

NOTHING has ever been made, except a noise or trouble, without work; and some of us work pretty hard sometimes in making both. No material thing has been made without work, some with a little work and a good deal of something else, and some with a lot of work and various other things. A puddler does a lot of work with little intelligence: Dickens killed himself with work; both using the simplest tools.

Nothing but ideas are created with intelligence alone, and no material thing can be made by labor. It is often said that labor creates everything—labor, alone, creates nothing. I have tried to think out something that labor could create, and could get no farther than an Indian gathering grass and making it into a basket, and, when I got through, found that there were three things that enter into the construction of the basket—material, labor, and intelligent direction; and the intelligent direction was quite as essential as the grass and the labor.

While the three things, Material, Labor and Intelligent Direction (skill or artistic instinct) are equally important, they are not necessarily equally valuable. The earth would grow grass enough for billions of baskets, and so it is cheap. Millions of white men could be found to collect the grass; but those who could weave the baskets are few, and, if baskets were a necessity and wanted in quantities, the basket weavers could demand and would receive a fabulous reward. This illustrates the whole subject of why some men receive more pay than others. It is the question of supply and demand. With a pair of scissors likely the Indian could make five baskets as readily as four without, and this introduces the fourth element—tools, and in most material structures the fourth element is as essential as the others: that is, it takes material and tools, labor and intelligence. I would like to carry this basket idea through as an illustration of about what takes place in real life. The Indian cuts, gathers and prepares the grass and makes a basket a day and sells it for a dollar, consumes some time in the selling even though customers come and buy. Another Indian can cut and gather the grass, but cannot make a basket: so he is worth only a half a dollar a day. A boy with a pair of scissors can prepare the grass, and each enough for four baskets, and, if the Indian is relieved of the selling, he can make four baskets a day, but cannot sell them. A young Carnegie grasps the situation, enters into an arrangement, hires the grass cutter and boy, agrees to sell the product and share the profits. There is, after paying for the help, $3 to divide, the Indian getting a dollar and a half, instead of a dollar, as before. He works no harder and does the agreeable part. This goes on all right until the supply exceeds the demand. Then is the time the Indian becomes dissatisfied, wants a new deal, and here is where the young Carnegie comes in. He says: "All right, I will take all the responsibility, pay the men, and give you 75 cents each for all the baskets you can make." Baskets pile up until Carnegie gets nearly to the end of his resources, when the genius of the merchant comes to his aid, and he takes some selected samples and goes to New York. And do you think he goes to the down-town stores and sells them at a reduced rate by the dozen? Not at all! He goes to the up-town aristocratic residences, creates a fad, and sells them for $10 each. The demand soon exhausts the supply. What can be done? Train some young Indian boys to make baskets, or raise the price? Young Carnegie does both. The Indian basket maker gets the profit off the boys, and Carnegie gets the profit off the business. Who has been injured? Not the Indian basket maker, for he may be living in a good house instead of the wigwam; not the helpers, as they are better paid than they ever would be if it was not for Carnegie; not the aristocracy, for the more they pay the better they like it. Carnegie gets rich. Off of the workmen? No! but by his foresight, courage and business ability or intelligence.

Everybody knew that young Carnegie had become rich; his associates were jealous and the employees were mad. In their minds they did all the work, and he got all the money. Some one said: "I only wish I had your chance." Young Carnegie knew more about the business than he did, and replied: "I'll sell out to you, if you want to buy." "Yes! But I suppose you will want three times what the business is worth." "No! On the other hand, I will sell out to you for one-half what it is worth. I want to get into something bigger." "Well, what will that be?" "A business ought to pay 10 per cent, hadn't it?" "Yes!" "Well, I made $5,000—last year, that would make, say, a $50,000 concern. I will sell you the whole thing, and you can step into my shoes for $25,000." So the new man turns promoter, forms a stock company, and lets in the lawyers, doctors, farmers and widows on the ground floor, and they buy a business that none of them knew anything about. No one knew how to run it, the business lived on a fad, and Carnegie knew enough to know that fads run out, and that it was past the summit of its prosperity; it failed years sooner than it would in Carnegie's hands; but failed, and the Indians ran out of a job, and Carnegie got the credit of swindling the stock holders out of their money.

Another subject shows up the relative value of work and intelligence quite distinctly; it is books. Two books of the same size will have the same amount of paper, printing and binding, have the same amount of study, work and care put upon its production, and one sells edition after edition, while the other turns out rubbish for the dust pile. And what is discouraging, there seems to be no way or person who can tell in advance which will be the one and which the other. A case of this kind has occurred in this city. Two books, one David Harum and the other one you would not recognize from the title. The latter had as much and more time and thought spent on it than the former, and, while David Harum sold the most copies of any book but Uncle Tom's Cabin of modern times, the other, of a thousand copies printed, a couple of hundred were sold, perhaps three hundred given away, and the rest are deposited in the archives of oblivion. The manuscript of David Harum was submitted to four or five different publishers, and all but the last one turned it down.

At times the labor and intelligence are centered in the one man, and again, there may be all four centered in the one man; but they are there, and, no matter what the man's ability may be, whatever he aims to do, he has to learn the trade: he has to learn to use the tools.

About as simple operations as there are is driving a nail or shoving a jack plane. Whoever drove a nail at first time trying? Few! And who, who has never tried, can shove a jack plane and make it take a shaving? Fewer still. One who has never tried, may draw a bow over a violin, and the chances are a hundred to one he will make a squeak; with a few trials he will make a noise; while the violinist, with the same instrument and same bow, will make a musical note. One may be an accomplished penman and a good grammarian without being able to write any sort of a letter, much less an accepted article.

In the learned professions—Doctors, Lawyers and Ministers, they all try it on the dog first, start in in the village or rural districts, the Dramatic Authors try out their first nights in Syracuse, and the manufacturers usually prefer the Mechanical Engineering graduate who has worked two or three years for some one else.

Again, let us consider the four elements—material, tools, intelligence and labor. If one can deliver only the labor, he furnishes only one-quarter, and is not likely to receive more than one-fourth of the results. If one has a trade and can furnish all of the intelligence, he can furnish one-half, and can fairly demand one-half; but, can the man with the trade furnish all of the intelligence? Seldom! There are lots of things for the proprietor to think out; in fact, I have lain awake too many nights thinking of the difficulties and devising ways to admit that. So do not make the mistake of thinking that knowing how to do things is all there is to it. People do not care what you know; but it is what can you do? And knowledge helps one to do; but that is all.

Leaders of organized labor make a great mistake when they tell the workmen that everything is produced by labor; but, as I have shown, that is not true, and parents make the same mistake when they tell their children they will never amount to anything if they don't get an education, conveying the idea they can can live without work if they get an education. This may be one of the reasons why the poor man's son outstrips the wealthy one, he knows he has got to work.

No matter what education one has, he has got to learn to work and use the tools. Mathematics is a tool, and education itself is a tool, and the learning to use them is a trade. I believe our educational system will be better when this view is taken of it. Learning to use tools means learning to use them skillfully; but that is not all. We must learn to use them with judgment. I do not much like the phrase: "Putting brains in your work," but using them with good judgment is an essential feature. Take the exact science of mathematics: In practice it turns out to be about one part science and three parts guessing or good judgment. Take the case of a steam boiler: A steel boiler shell, properly constructed of steel 1/16 inch thick and 5 feet in diameter, will stand a pressure of 100 pounds to the square inch: this any of you can figure out; but one boiler maker says you ought to have a factor of safety of 4, and he makes it 1/4 inch steel plate. Another boiler maker says you ought to have a factor of safety of 5; but, as he has no 5/16 inch steel, he makes it 3/8 inch. So, what do you have? One-quarter by figures and three-quarters by guess. Or, to put it better, one-sixteenth by figures multiplied by from four to six, which experience has shown is best. And so it is with a great many mathematical computations—figured out fine; but on uncertain factors. Take the case of cast iron, which varies fully 50 per cent in strength: the best that can be done is to get the general average of the run of the foundry, take the strength of test pieces and add a big factor of safety. Test pieces of the same size and cast from the same ladle of iron will be different by quite a percentage, and figuring down to the fourth decimal is making a fool of mathematics. Many times complicated mathematics are used in determining things that a simple diagram will settle. This is common in determining bridge strain diagrams. Some will say that the diagram way is not accurate. What does it matter when you have to guess at the prime factor?

In mechanical industries there comes a fifth element, invention. Few, I believe, have stopped to think of the part invention and design (another sort of invention) plays in building up the industrial enterprises. Take an example from invention in the history of our city: At first sight one would fail to find in the Solvay Foundry, which is simply a malleable iron foundry, much, if any, evidence of invention; but the origin of the thing goes back to the invention of making malleable iron: and sixty years ago the Frazer & Jones Company was composed of Mr. Frazer (an inventor) and a business man, Mr. Burns, a combination that built up a new industry which could not have prospered as it did without Mr. Frazer's inventive ability, and, that grew into the Solvay Foundry Company, which is the continuation of that, as is the Syracuse Malleable Iron Works, managed by Ex-Mayor Burns.

The Solvay Works, the Pass & Seymour Company, the Eckel-Nye Steel Company, and over a dozen other local companies might be cited among those founded on invention and design.

For every industry where a patent has been instrumental in building it up, I have no doubt but there have been a hundred patents taken out—some of merit and many worthless. Some of the meritorious ones died for want of good business management. So that there are good inventions which turn out bad, and some worthless inventions that money changed hands over; but what one man gained, another lost.

Necessity is said to be the Mother of Invention; in late years it would appear as if Trade Unionism was the Father. Labor disturbances, and the fear of them, has caused the development of many wonderful inventions which has dispensed with the services of the very men who caused or threatened the disturbance, and in cases of the widest character of service. The linotype machine in the place of type-setters, and concrete mixers in place of the shovelers.

Some years ago it took fourteen men ten hours to unload a freight boat of 900 tons of iron ore; now an unloading machine unloads 9,000 tons with only four or five men in the same time. Molding machines a few years ago began to replace molders in making small duplicate work.

A short time ago an engine company in Ohio had a strike on, for what they deemed an unjust demand, so they (from the inspiration of the Father of Invention) concluded to make castings without the molders, and found that by shaking the flasks the sand would ram itself, so castings of the largest size and most intricate form can be made with one-quarter the molders, and they relieved of the toiling work that it took before. And so it is all along the line—the inventors are at work, and then you will say the inventors ought to get rich, and that they don't get their just reward. Those whose inventions achieve success generally get their proportion, because it is seldom that the invention is the whole thing. After the invention is made, the thing has to be made, and after that it has to be made to go. If it is something that has to be sold, the public has to be convinced of its merits; the business has to be financed. So the inventor who has a patent, and

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has an offer for it, had better sell out, if he can do so on any fair terms and under any arrangement. If the invention and patent are good, sell at a low figure with a royalty; if of doubtful utility, get what you can, and if the purchaser later works out some way to make it go, don't complain.

Ninety-nine out of a hundred of the young men who catch the inventing microbe have a passport to poverty; and the newly fledged inventor always makes two big mistakes. He is dead sure someone is going to steal his invention, which they never do; and the next thing he is pretty sure to think, it is worth millions, while, as a matter of fact, not ten out of a hundred of the patents taken out are worth the paper they are written on, although there is a much larger proportion that the inventors get their money back; but someone else has to lose.

Learn to invent; learn to design, which is a much rarer faculty; but don't go daft on your invention. While the laborer does the work, the mechanic, the labor, and in part, or wholly, the intelligent direction, the proprietor furnishes the shop and machines, the tools and material, the inventions, and one other thing (and one that seldom appears), the worry, the sleepless nights, and the almost irresistible desire to slight the product. Why does the proprietor worry, and what does he worry over? When to build and how? Where to get the best stock or the cheapest? What machines to buy? What to build? Who is to be foreman? How can the things be improved or built cheaper? Where is the working capital to come from? Are the customers good, and will they pay when they agree? When will the men strike for higher wages or demand the closed shop, and take the business out of your hands, all but paying the bills? Selling the goods is a big part of the work. So worry makes a sixth point to the six pointed star, which shines so brightly in the eyes of those who know nothing about the work and worry, money and thought it has taken to produce it.

It is easy to pick out the twenty-five industrial concerns in the city that have prospered, and forget the fifty that have gone into bankruptcy. Those that failed had had material, tools and labor, the same as those that have succeeded. So it was not the lack of these things that were the cause of their failure; but the lack of invention, lack of conception, intelligent direction, business management or courage, all embraced in the one work genius.

There is still another thing—Character. The ruling powers of a great concern have to maintain agreeable relations with the people they deal with, with those they buy from, those they sell to, with their workmen and their agents, which it is not always easy to do.

It is easy to be good natured when the concern is making money, and the men are not kicking for more pay or shorter hours; but, when one is losing money, and the men grouchy (and the two usually come together) it is not easy to put on a happy face.

Whatever you do that is worth doing, you have got to work; learn to take an interest in your work; cultivate a love for your work, and to be proud of what you make, and remember Ruskin's remark on viewing a locomotive which was: "What can the man, who can take iron rust and make it into a locomotive, think of me—making marks on a piece of paper with colored water?"

# The Conference of Washington*

## Meeting of the International Union for the Protection of Industrial Property

### By William Osborn

THE Senate of the United States on February 6th, 1912, removed the injunction of secrecy from the convention signed at Washington on June 2nd, 1911, by the plenipotentiaries of the governments forming the International Union for the Protection of Industrial Property, revising the Paris Convention of March 20th, 1883, as modified by the additional act signed at Brussels on December 14th, 1900.

The convention, which will hereafter be known as the Treaty of Washington, was signed by the delegates representing the nations adherent to the Union, in Washington, in a single copy, and was transmitted to the Senate by the President of the United States on December 21st, 1911. Under its provisions ratifications should be filed at Washington, with the Department of State, at the latest on April 1st, 1913. It shall be put into execution, among the countries which shall have ratified it, one month after the expiration of this period of time.

This treaty, with its final protocol, displaces in the relations of the countries which ratify it: the Convention of Paris, March 20th, 1883, the final protocol annexed to that act; the protocol of Madrid, April 15th, 1891, relating to the dotation of the International Bureau and the additional act of Brussels, December 14th, 1900. However, these acts cited shall remain binding to the countries which adhered to them, but who do not ratify the Treaty of Washington. A full text of the new treaty is published in the *Daily Consular and Trade Reports*, issued by the Bureau of Manufactures, Department of Commerce and Labor, and copies may be had upon application.

It will be necessary to discuss at length the purely formal changes which the Conference of Washington has made in the text of the convention. The word "countries" has been substituted for "states," which is more suitable in view of the diversity which prevails in the national constitution of the contracting countries. Article 1 omits the enumeration of the contracting countries, which no longer applies to existing conditions, and which, if brought up to date, would cease to be exact as soon as a new country joined the Union. In articles 5, 13 and 14, new provisions have been introduced which are purely and simply a reproduction of texts appearing in the final protocol annexed to the Convention of Paris.

The following is a brief consideration of the articles of the convention which have undergone more or less important changes, or the revision of which has been discussed.

The enumeration of the different branches of industrial property to which the convention is applicable has been supplemented, first, by mentioning several of such branches which, while not mentioned in article 2, already formed the subject of provisions contained in preceding acts; and by adding "utility models," which according to circumstances participate either in the nature of patents or in that of industrial models.

This article has received another important addition of particular interest to American inventors and manufacturers. Certain courts have interpreted the assimilation of foreign subjects of the Union with citizens, which is sanctioned by this article, to mean that the protection of the former is subject to the possession of a domicile or of an establishment in the country wherever the national laws impose this requirement upon its own citizens. This requirement is not a hardship for a citizen who in most cases is domiciled or established in his country of origin, but it is a great hardship for a foreigner who as a rule is not in that position. And it is certainly contrary to the spirit of the Convention of Paris, the object of which is to break down in every country the obstacles which oppose the protection of foreigners. The conference, therefore, has done valuable work in declaring expressly that "no obligation of domicile or establishment in the country in which protection is asked for shall be imposed upon persons under the jurisdiction of the Union.

In other words, under the Convention of Washington, citizens of countries belonging to the Union—United States citizens, for instance—may enjoy the full protection of the patent and trade-mark laws of foreign countries, without being under the necessity of establishing a domicile or place of business in that country in which patent or trade-mark protection is sought. The United States gives that protection under its patent laws, but its citizens have not enjoyed the same rights in all foreign countries.

Article 4 has been amended to point out more specifically the manner in which a person may avail himself of the priority of an earlier application in one of the countries by filing a certified copy of the application thus relied upon. In article 4 bis, the conference inserted a provision which clearly establishes the absolute independence of the different patents, "both from the point of view of the causes of annulment and forfeiture and from the point of view of normal duration." This amendment makes more certain the rights given to a party who seeks to take advantage of the provisions of the convention relating to priority. The text of this article has given rise to contradictory interpretations. It has been generally understood to mean that patents which a person has obtained in the different countries of the Union, for one and the same invention, are absolutely independent of each other. But on the other hand it has been claimed that such independence existed only with regard to the connection which from the time of delivery of the patent was established between the life of the latter and that of a patent of earlier date.

Article 5 is substantially identical with the original article 5 as amended by the convention at Brussels in 1900, and which is now in force. This article has to do with the compulsory working of patented inventions and there was adopted only a slight modification which defines the bearing of the term of three years granted for working the invention. It is to be understood that such term shall not be shortened by any provision of national laws. This result cannot be surprising. Certain recent laws which have sanctioned the system of compulsory working could not well be modified until such system has been tried for a sufficient length of time. On the other hand the German law which modifies the compulsory working of patents received imperial sanction only in the course of the conference, and several countries will no doubt wish to learn the result of the same before making a decision with regard to a question of such importance.

Article 6, which relates to the registration of trade-marks has been somewhat amplified for the purpose of excluding from registration such devices as, under the common law of the United States, would not be recognized as trade-marks. This section of the amendatory convention conforms very closely to the trade-mark law of the United States passed in 1905. The most important modification made in article 6 is that which states the cases in which Union trade-marks may be rejected in spite of the provision of the first paragraph which makes it obligatory to admit them *telles quelles* (such as they are). In order to obviate all contests and recrimination, the conference has specified in the section paragraph of article 6, the cases in which it will be permissible to reject a Union trade-mark registered in its country of origin.

The Convention of Paris declares in its final protocol that:

"The use of public coats of arms and of decorations may be considered contrary to public order."

Some countries have interpreted this provision as permitting the rejection of trade-marks which contain such elements even when the use of the same had been expressly authorized by competent authorities. This was obviously going too far for the respect of public authorities requires at the same time that the abusive use of its insignia be repressed, and that trade-marks in which they appear by their permission be admitted to protection. The conference has taken this fact into account in declaring, in the final protocol, that "trade-marks which contain by permission of competent powers the reproduction of public coats of arms, decorations or insignia, are not contrary to public order."

Article 7 is identical with article 7 of the convention now in force. Article 7 bis, provides for the registration of collective marks, that is to say, a mark which has been adopted by a collection of individuals or associations. The present trade-mark laws of the United States do not provide for protection of marks of this character and considerable agitation has been had in recent years, for the inclusion in the trade-mark law of provisions permitting registration of marks of this character as for example, a general mark which may be adopted to indicate that merchandise is produced in a particular locality, as that used by the California Fruit Growers' Association. A notable instance of this is also the adoption and registration in Great Britain of a mark which is applied to goods of Irish manufacture.

The State of California has in its trade-mark law recognized the right of registration of such marks and it is generally believed that such registration should be permitted under the federal law relating to the registration of marks for interstate commerce. Many of the foreign countries now permit such registration and there appears to be no reason why this country should not do so. Article 7 bis, as above described is an entirely new provision which was adopted by the Conference of Washington.

The Convention of Paris provides only for the accession of new countries to the Union and does not speak of the accession of the colonies or possession of the contracting countries. The Conference of Washington has made up for this omission by a provision which gives to the mother country every possible facility for acceding to the convention for all or part of its "colonies, possession dependencies and protectorates" or for mentioning them by name.

This is especially interesting to American manufacturers who have extensive trade relations with the dependencies of various foreign countries and who have been confronted with problems concerning the application of international laws to those dependencies.

According to the program the persons under the jurisdiction of the Union should be permitted to establish their rights before the consular jurisdiction of each of the contracting countries, wherever such jurisdiction exists. This proposition tended to replace

* Held at Washington, May, 1911.

among the countries of the Union the bilateral arrangements which the Governments stipulate among themselves whenever they wish to insure mutually to their respective subjects the enjoyment of extra-territorial jurisdiction for a certain territory.

One delegation proposed to specify expressly what had already been given to understand in the program, namely, that the benefits of consular jurisdiction should be subject to previous compliance, in the country to which the consular tribunal is subject, with the requirements and formalities necessary in order to be entitled to invoke such jurisdiction.

Another delegation observed that the consular jurisdiction is not always applied by all the countries of the Union and that often it is not applied to the same extent. This delegation proposed, therefore, to subordinate the application of consular jurisdiction to the condition of reciprocity and to invite the contracting parties to come to an understanding by special agreements as to the question whether and to what extent reciprocity should be considered to have been established.

The result of this system would be to bring the contracting parties back to the regime of special conventions which was the very thing sought to be obviated.

When the system proposed was put to a vote it obtained a large majority, but in the absence of the required unanimity it was not introduced in the convention. On the other hand the conference adopted the wish whereby the International Bureau is invited to consider the question of the establishment, in the countries having consular jurisdiction, or registers insuring the protection of trade-marks without obligation of deposit in the country to which the consular tribunal is subject.

# The Deutsch Aero-Dynamic Institute, Paris

## An Establishment for the Study of Problems Relating to Aviation

### By the Paris Correspondent of the Scientific American

IN the early part of 1909 Mr. Henri Deutsch informed the Minister of Public Instruction of his intention to offer to the Paris University the sum of $100,000 and an annual income of $3,000, for the establishment of an aerodynamic institute, designed to give all the requisite facilities for researches in the field of aeronautics. The University accepted this offer, and then came the task of drawing up plans for buildings and grounds properly equipped, to provide a center for aeronautic research. Among the first problems to be studied by the Institute is the determination of the best shapes for aeroplane surfaces and the study of the reaction of the air upon various kinds of surfaces. Another important subject for study is that of stabilizers for aeroplanes, and a number of other points.

The Machine Shop of the Institute.

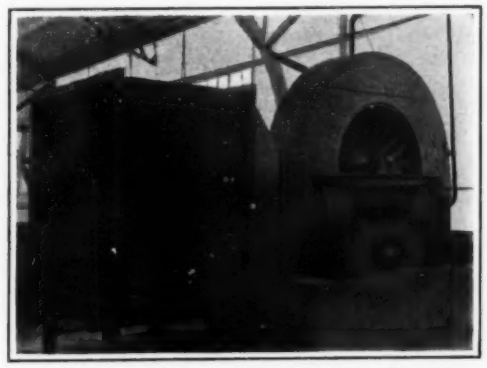
This institution has come just at the right moment and we shall look to it for many interesting developments.

The first and foremost requisite is a long, straight experimental track upon which cars could be run with aeroplanes or screw propellers attached to them for purposes of tests. For experiments on a smaller scale a covered circular track was required. A good piece of flat ground was selected at St. Cyr, near Versailles, in the neighborhood of the military aeroplane grounds. Prof. Maurain was appointed director of the Institute, in view of his important contributions to technical aeronautics, and it is to him that we are indebted for the data here presented.

The grounds are about 4,500 feet long by 85 feet wide and are perfectly flat and free from trees. The buildings comprise a vast central hall covering 1,300 square yards, the interior of which is shown in one of our illustrations. Here there will be installed a variety of different kinds of apparatus for aero-dynamic studies. One such device is shown in one of our views. It consists of a powerful blast fan, which delivers a current of air to a square wind box, divided into a number of cells by a honeycomb arrangement of partitions. The purpose of this is to render the air pressure uniform and to produce a broad stream of air of uniform character.

The "Straight Track."

Adjoining the main hall are a number of smaller rooms, including a chemical laboratory for examining gases, balloon envelopes, and the influence of heat, light, etc., upon fabrics and various other materials, etc. There is also a physical laboratory for testing various apparatus, and in particular physical measuring instruments. Ample provision has been made for photographic work, and upon the roof is a small meteorological station. One of our views shows the machine shops, which are provided with every convenience and modern equipment. There is a special electric plant with boiler room and dynamos, to give the requisite current for the entire establishment. The circular track mentioned above is located within a building of 130 feet diameter. Motor-driven arms pivoted at the center of this track carry the surfaces to be tested. One of the most interesting features is the long straight track in the Institute grounds, on which the special testing cars are run. One of our engravings gives a view of such a car, as designed by Prof. Turpain. The car is propelled by an electric motor carried on board. In order to test a given aeroplane surface it is attached to a frame provided for this purpose on the car and mounted upon pivots, so that the surface under examination can be arranged at any desired angle. The pressure of the wind upon such surface is recorded by means of suitably arranged dynamometers and is registered upon a drum as the car moves along. A special instrument records the normal pressure alone, which of course is a point of special interest. It is also necessary to know the exact speed of the car, corresponding to the different pressure measurements made. This is done by means of a special speed-recording drum, while a recording watt motor indicates the power consumed by the car. From all the data thus gathered one can obtain a very good idea of the behavior of the aeroplane surface under different speeds. The value of such tests in the design of aeroplanes is so obvious as to require no further comment.

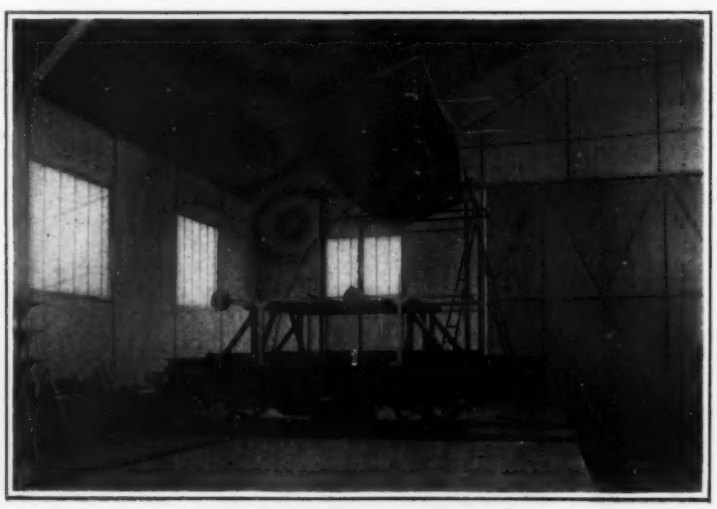


Blower for Powerful and Uniform Blast.

The total weight of the car is 4.2 tons, exclusive of the motor, which weighs 1.2 tons. The car measures 20 feet in length and 6 feet in height. The front of the car is parabolic in shape. The distance between axles is 12 feet. In order to bring the weight well forward onto the front axle, so as to prevent the wind pressure from lifting the car off the track, the iron body is extended much farther beyond the front axle than the rear axle. The motor drives both axles by a chain drive. A long track has been laid down, in order to provide a good run for the car, especially at high speeds. It is 4,600 feet long and of the regular standard gage. On each side is a contact rail for the current, while the track rails serve for the return. There is no motorman on board, the car being operated entirely from a conning tower situated at the back of the building. The field and armature of the motor are fed separately, and the man in the conning tower operates a controller arranged much like any ordinary car controller, to regulate the speed of the car. To stop the car at the end of its journey, a special pair of flat rails is provided, and the car carries brake shoes bearing against these rails, whereby it is quickly brought to a stop. The pilot can also put on the usual electric braking action upon the motor in case of need.

France has taken a leading part in the developement of aviation, and it seems only fitting that her capitol should harbor such an Institution as that here briefly described.

The Main Hall of the Aero-Dynamic Institute.



Car for Testing Planes and Propellers.

# Mechanical Water Softener

## An Important Adjunct for Boiler Plants

THE accompanying illustration, Fig. 1, shows the installation of an English water softener having a capacity of 5,000 gallons per hour, reducing a very bad water from 54 degrees to 6 degrees of hardness. The drawing, Fig. 2, indicates the construction and method of operation of the apparatus.

No doubt the use of hard water in steam boilers and the presence of the resulting scale produces an annual loss, the magnitude of which is even now hardly

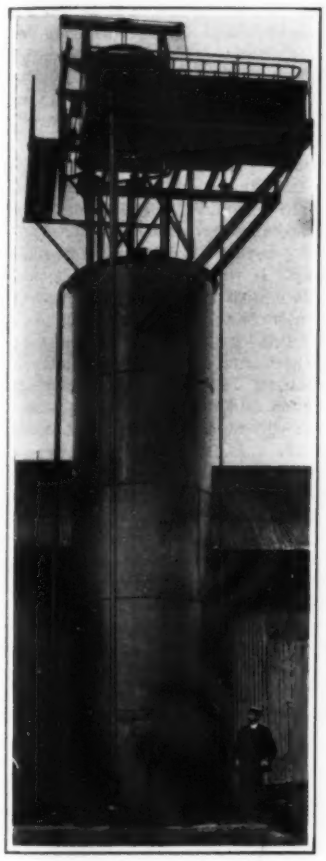


Fig. 1.—Perspective View.

ealized. The causes of such loss include the waste f fuel, cost of periodical scaling, and damage to the oilers in chipping off the scale, hence the reduced life f the boiler and increased depreciation charges. In d cases where the boiler must be laid off for scaling times other than holidays, there is in addition the forced idleness of those not under steam.

Regarding the reduced life of the boiler it may be entioned that the temperature of the plates is much creased by the presence of scale, and every time e furnace door is opened the contraction produced the cold air produces stresses enormously greater an would be the case with plates at a lower tempera re.

The rapid corrosion of boiler plates taking place with rtain feed waters is due to the presence of magnesium oride which can be removed by softening the water; ch waters may not be forming much scale in your ilers, but they will very seriously corrode them and ll proportionately reduce their life and increase your preciation charges.

t may be stated that the hardness of water is esti ated by the number of measures of a standard soap ution which it is necessary to add to a measured volume of hard water in order to produce a permanent lather. The test is quite simple, but one has to distinguish two kinds of hardness, temporary hardness and permanent hardness. Temporary hardness is so called because it can be removed by long continuous boiling; thus, by boiling down the water to half its original bulk, a large part of the temporary hardness would be removed. It is not possible to remove the temporary hardness by simply raising the water to the boiling point by means of exhaust steam; it must be boiled down to a small bulk if it is to be softened by heat alone, and there is no apparatus which can produce good results by simply heating the water to boiling point, while the expense of boiling down to half its bulk is prohibitive. The best method is to add lime to the water; this combines with the carbonic acid, which holds the carbonate of lime in solution, and carbonate of lime means temporary hardness.

In this way the temporary hardness can be removed without the use of steam; nevertheless, if exhaust steam is available, an even better result can be obtained, not because the steam alone could produce any result, but because chemical reactions take place more rapidly at higher temperatures.

The temporary hardness can be estimated by a test just as simple as the one with soap described above. The permanent hardness is found by deducting the temporary hardness from the total hardness. It is so called because it cannot be removed by boiling the water; e. g., boiling the water down to half its bulk would have no effect on the permanent hardness. If the water be boiled down to a small fraction of its original volume, a condition realized in a boiler, then the permanent hardness which is due to the presence of sulphate of lime (plaster of Paris) causes the formation of very hard scale. This formation of scale from this cause is further assisted by the fact that sulphate of lime is less soluble at the high temperature of the water in the boiler than it is in water boiling under atmospheric pressure. The permanent hardness is precipitated, that is thrown out of solution in the form of a powder by chemical means, with carbonate of soda, commonly called soda ash.

The lime and soda ash precipitate the hardness before it enters the boiler and in the apparatus here described the powdery precipitate is removed by a thoroughly efficient filter so that it never enters the boiler at all.

Where exhaust steam is available the combined water softener and feed water heater is used to advantage, completely separating the oil in the exhaust. With steam coal at $1.50 per ton, it costs 12 cents per thousand gallons to raise the temperature from 50 deg. Fahr. to 200 deg. Fahr., and if using five thousand gallons per hour this means a saving of over $1,000 yearly.

The water softener must obviously fulfill two kinds of functions. In the first place, certain chemical reactions must be carried out; and secondly, the resulting precipitate must be removed by proper mechanical filtering devices. Under suitable conditions the filtering may at the same time remove the oil from the condenser water.

As regards the mechanical equipment, the water softener should be as simple as possible and free from any complicated parts which would be likely to get out of order. These conditions seem to be well fulfilled in the apparatus here described and figured. Referring to the drawing, hard water enters tank *A* by the two-way valve *B*; a float *C* rises while chains *E* and *F* descend, the descent of the latter causing the scoop *G* to enter the chemical tank *A*. To the chain *E* is attached a very simple tripping gear which comes into action when the tank *A* is full, the gear in conjunction with the two-way valve *B* shutting off the hard water supply in the tank *A*, and putting this tank into communication with the discharge pipe *I*. The hard water now discharges through the cone *J*, drawing air in along with it, while the baffle *K* diverts the current of air upward, causing it to pass through the top of the cylinder *L* and thence through the pipes *M*, *N*, $O^1$, $O^2$, $O^3$, etc., to the bottom of the chemical tank *H*. Air is an ideal agitator and thoroughly stirs up the milk of lime in the tank.

As the tank *A* is now emptying, the float *C* descends, this pulls up the scoop *G* which is pivoted at *P*, and which now discharges its contents through *Q* and *R* to join the hard water. The passage of the water and chemicals together down the pipe *S* and cylinder *L*, the dashing against the baffle plate *K*, and the admixture of air, which is an ideal mixer and stirrer, insures a very intimate mixing of the hard water and chemicals. The water now passes by the openings in the bottom of the cylinder *L* and the stand pipe *T* to the filter *U*.

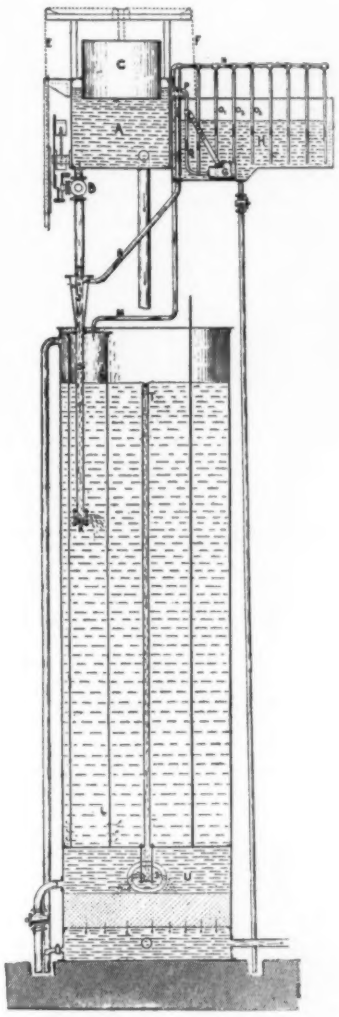



Fig. 2.—View in Section.

The filter is a sand filter, and is washed by a return flush without removing the filtering material. When the tank *A* has finished discharging, the fall of the float *C* brings the tripping gear into action again, the connection between the tank *A* and the pipe *I* is broken, and the former is again put into communication with the hard water supply, after which the cycle of operations repeats itself.

### Mayers Paper on the Conservation of Energy

THE recent issue as one of the volumes of Ostwald's Klassiker der exakten Wissenschaften" of Robert Mayer's two papers of 1842 and 1845, on the subject now known as the conservation of energy, will prove a great boon to those interested in the early history of that great generalization. Traces of the idea may be found among the ancients, and Descartes held that it was a self-evident truth. But in the middle of the seventeenth century the term energy had but vague significance, even in the simple case of a moving body, and the doctrine of conservation, when held, meant little or nothing for physical science. Toward the middle of the nineteenth century interest in the question appears to have been widespread. Seguin in France in 1839 calculated the mechanical equivalent of heat from the fall of temperature of steam when expanding against external pressure; Joule in England in 1840 showed that when a battery of cells drives a motor the consumption of zinc in the cells is proportional to the work done by the motor; and Mayer in Germany, after explaining how the term energy was to be understood, stated the generality of the law in his first paper in 1842, and with greater clearness in his pamphlet of 1845.

The titles of Mayer's publications were not such as to suggest the subjects treated in them, and they were so little known, even in Germany, that Helmholtz in 1847 published his paper on the subject without any reference to Mayer. In the meantime, Colding in Denmark had read a paper to the Royal Society of Copenhagen in 1843 in which he stated clearly the law of conservation of energy, and Joule read before the British Association in the same year the first of his papers on the measurement of the mechanical equivalent of heat. Before the middle of the century Joule's experimental work had placed thermodynamics on a firm basis. When the contributions of Seguin and of Colding, and possibly of others whose work has been overlooked, are republished in a form as accessible as are those of Mayer, Joule, and Helmholtz, it may be possible to apportion the credit for one of the greatest generalizations of the nineteenth century in a way to satisfy even the most captious critic.—*Nature.*

**Mass for Removing Rust.**—Melt 20 parts of olein, 2 parts tallow and 4 parts paraffin on the water bath and with this mixture incorporate 30 parts of finely powdered pumice stone.—*Seifenfabrikant.*

# Directed Radio-telegraphy Without Vertical Antennæ*

## Horizontal Wires Are Found to be Fully Efficient

AN important contribution to the problem of the propagation of Hertzian waves in radiotelegraphy was presented to the Deutschen Physikalischen Gesellschaft at Berlin on October 20th by Dr. Franz Kiebitz, of the research staff of the German Telegraph Department. High vertical antennæ are at present used because the waves are supposed to travel essentially through the atmosphere. At the same time it is generally admitted that the earth plays some not well-understood part in the phenomena. Kiebitz now proves experimentally that efficient radiotelegraphic communication can be maintained without any aerials, merely with the help of earth antennæ, i. e., wires stretched horizontally near the earth's surface, above it or embedded in it, and that the waves can be directed with such arrangements. Horizontal antennæ are, of course, not novel. They have been tried by several investigators. On board ship wires are stretched high up between the mast-heads, and at Clifden parallel horizontal wires are supported by double rows of high poles or masts. But a suspension high above ground has been considered necessary,[1] and these antennæ are charged with strong currents at very high potentials, which render the insulation very difficult. The earth antennæ can be carried close to the ground or be buried in it, and they are charged with weak current whose insulation does not cause any difficulties. The experiments so far made are not conclusive, of course; and it may be that the great simplicity of the installation will vanish as the system develops, finally to be, possible, again reacquired. But it looks as if high vertical aerial antennæ could certainly be dispensed with in certain cases, because the earth takes its share in propagating the electric waves.

That this is so was already believed years ago. Since two stations separated by the curved earth can communicate with one another, it was assumed that the electric vector of the propagating waves was essentially vertical to the earth's surface. E. Lecher argued, in 1902, that radiotelegraphy was based upon the spreading of electric charges on the earth's surface, and that it would be possible to telegraph, in particular directions, with two earth antennæ. Prof. L. Zehnder, of Halensee near Berlin, patented, in 1905, a simple arrangement for this purpose. The principle of this arrangement, which is the same as that adopted by Kiebitz, is the following: Two earth plates, $C_1$ and $C_2$, are connected by wires with a source of alternating currents of moderate frequency $A$; the lengths of the two wires $C_1$ $A$ and $A$ $C_2$ are $l_1$ and $l_2$, and the relation between them and the wave-length $\lambda$, given out by $A$, is such that $(l_1-l_2)/\lambda+x/\lambda_1=½$, where $x$ is the distance between the two earth-plates, and $\lambda_1$ the length of the wave corresponding to $\lambda$ when passing through the earth. The whole wire system is tuned to wave-length $\lambda$; the corresponding $\lambda_1$ will be considerably smaller than $\lambda$ (the waves are shorter in metals, water, etc., than in air), and it will therefore be possible to make the distance $C_1$ $C_2=\lambda/2$, without letting this distance become inconveniently large. As a rule, $l_1$ and $l_2$ will each be about equal $\lambda/4$. The $C_1$ and $C_2$ are in reality earthed condensers. Zehnder was quite aware that the want of homogeneity in the earth strata would complicate the phenomena and would disturb the tuning, because the waves would be diffracted and refracted, and that mountains, rivers, valleys, and heavy local rains would affect the propagation of the waves; he also pointed out that when earth-plates were inserted in a lake, islands situated between them would make a difference. Zehnder has recently[2] ascribed the fact that the radiotelegraphic range is shorter in daytime than at night to the circumstances that the sunlight heats and dries the earth and the air, and causes winds and convection currents in both these media, and that electric waves would irregularly be refracted and reflected just as light waves.

We pass to the experiments of Kiebitz. They were undertaken with the assumption that Hertzian waves in the air and electric-charge waves in the earth's surface must mutually influence one another, and that the electric field is essentially vertical to the earth's surface, even close to the transmitter, as he demonstrated in 1908. He considers that the earth antennæ, i. e., straight lengths of wires, behave like metallic cores embedded in a semi-conductor, that these cores have a selective conductivity for certain wave-lengths, and that it is hence possible to generate stationary waves in them, which will be radiated out. The phenomena are therefore those of selective emission and absorption.

Kiebitz made his experiments last summer on a sandy heath near Belzig, situated 65 kilometers southeast of Berlin; the lakes or broads of the winding Havel River are to the north of the straight line Belzig-Berlin and partly near it. The station consisted of a shed $S$, and earth antennæ or wire lines were laid in different directions, but always in straight lines $E_1$ $E_2$, $E_3$ $E_4$, etc., and such that the shed $S$ was in the middle of $E_1$ $E_2$. The lines ended in earth-plates which were not always in circuit, however; these earth-plates consisted of seven or four zinc sheets, embedded in the moist sand in pits, 4 meters in depth. Earth-plates were also arranged symmetrically around the shed $S$. The lines themselves were of different kinds and lengths: bronze wires, 1.5 millimeters in thickness, stretched on china insulators fixed on wooden poles, 1 meter above ground, or insulated with gutta percha and placed in a shallow conduit; or 0.8 millimeter copper wire, stretched on poles, 8 meters in height; or copper ribbon, 2 centimeters in width, 0.2 millimeter in thickness, mounted like the bronze wire. In and near the shed where the lines crossed, insulated copper wires, 1.5 millimeters in thickness, were used. The nature of the line did not make much difference on the whole; but the copper ribbon on 1-meter poles frequently came out best. Near each terminal was mostly a battery of Leyden jars. The two lines, the $l_1$ and $l_2$ of Zehnder, were joined in the shed to a split coil, connected in the middle to a variable condenser; the circuit comprised a contact-detector (a crystal of galena pressed against graphite) and a telephone. The intensity of the signals received was estimated, as usually, by the parallel-ohm method; a resistance free from self-induction is coupled parallel to the telephone, and this resistance is diminished until the signals cease to be audible. When this minimum resistance is 20 ohms, e. g., it would be said that the operator was receiving with 20 ohms.

Signals from the station at Schöneberg, Berlin, situated in the exact continuation of the earth antenna (or line) $E_1$ $E_2$, 65 kilometers away, were best heard (with 6 ohms) when the insulated wire in the conduit or the copper ribbon were used. Swinemünde, 230 kilometers to the north, at an angle of 23 degrees, was easily heard. The great station at Norddeich, 405 kilometers to the west, was also heard, even when—without making use of the just-mentioned earth antenna—an insulated wire, 700 meters in length, was simply placed on the ground in the direction of Norddeich, i. e., east-west. The Eiffel Tower signals (810 kilometers) were distinctly overheard; there a wave-length of 1,000 meters appeared to be used. The Admiralty station in Whitehall was overheard day and night, with the earth antenna of 240 meters length, while the radiotelegraph station at Schöneberg, Berlin, which is equipped with an aerial 40 meters in height, can only understand these signals at night time. Poldhu was also overheard. The experiments seemed to show that Poldhu used a wave-length of 2,800 meters, and Whitehall a wave-length of 3,400 meters. In order to facilitate receiving from Clifden (1,550 kilometers) and Glace Bay (in Canada, 5,100 kilometers), a wire-line of a length of 1,270 meters (¾-mile, roughly) was laid in the direction of Glace Bay; the insulated wire rested partly on the ground and partly on the lower branches of the trees of a bush adjoining the heath; the earth terminals were formed of wire netting. The receiving apparatus was the same as before, but it could be tuned to wave-lengths ranging from 3,000 up to 8,000 meters. Clifden was easily listened to in the third September week; Glace Bay was occasionally heard between 6 A. M. and 7 A. M.; but thunderstorms greatly disturbed these signals. The determinations of the wave-lengths gave 5,600 to 5,800 meters for Clifden, and 5,800 to 6,000 meters for Glace Bay. Atmospheric and earth currents very frequently caused trouble, especially in July, when, with a perfectly clear sky, distant thunderstorms were often heard.

Further experiments were made with the object of fixing the influence of the direction of the transmitting station by the aid of the radiogoniometer of Bellini and Tosi. For this purpose an antenna cross was used, consisting of two lines, one north-south, the other east-west, crossing at the station shed $S$. In many instances the direction of the transmitting station (e.g., Poldhu and Paris) was correctly estimated within 3 degrees. But there were curious anomalies. Schöneberg (only 65 kilometers distant) sometimes appeared to be in a direction wrong by 8 degrees when waves of 1,400 meters were used, and wrong by even 10 degrees when waves of 2,900 meters were used. The direction of Norddeich was correctly estimated on some days, and appeared deflected by up to 7 degrees on others.

For the transmission experiments current was generated by a 2-kilowatt alternating dynamo giving currents of from 400 to 700 periods. These currents were transformed up, and the primary was closely coupled with the secondary coils of the previous arrangement. Schöneberg was easily reached; waves of 1,350 were received at Schöneberg with an intensity of 40 ohms. Swinemünde was likewise reached. Norddeich could hear faint signals when the 1,270-meter wire and waves of 3,500 meters were used, and currents of 1 kilowatt supplied to the antenna, although the insulation of the long wire was very poor. But Schöneberg, although much nearer, could not hear these signals, the reason being that this antenna made an angle of 8 degrees with Norddeich, but an angle of 122 degrees with Schöneberg.

From these and other experiments Kiebitz concludes that horizontal earth antennæ, close to the ground or in the ground, could be used for radio-telegraphy. Earth-plates would not be necessary, but may be advisable; the antenna must be of great length, however, and such that the pressure has its maximum at the ends, and the current its maximum in the middle. In some respects a line with insulated ends, half a wave in length, close to the ground, would be best; but such a line would be unsuitable for close coupling. It would therefore be better to let the system oscillate with two half waves, such that loops form at the outer ends of the two wires and at the variable condenser, and nodes at the inner ends of the wires. In any case the horizontal antenna arrangement would offer many advantages. It would be much cheaper than the vertical antenna and less exposed to atmospheric disturbances, though more sensitive when tuned to long waves, a rather unfortunate circumstance. The possibility of working with close coupling and yet feeble currents (4 amperes were used in the transmission Belzig-Swinemünde, and the antenna gave only very small sparks) of alternating generators was, on the other hand, a great advantage. Small stations and ship stations for small wave-lengths would probably retain their vertical aerials, Dr. Kiebitz thinks, for large stations using waves of lengths exceeding 1,000 meters the horizontal earth antenna would be preferable.

In conclusion we would like to refer to a suggestion made by Zehnder. He accentuates that his arrangement sends out directed signals, and further that the much-desired secrecy of radiotelegraphic messages can be secured in a very simple way. Any code can be deciphered, he points out, if used for some time, because certain letters occur far more frequently than others. If, however, the code were changed at intervals, deciphering would become impossible. The message should simply be typed out on a special machine. When the typist begins, the characters a, b, c, d, e, f would correspond to x, m, o, s, a, g, for instance. When a line has been typed the type-wheel is turned through one tooth; then the characters a, b, c, d, e, f mean m, o, s, a, g, v, and so on. The same machine would decipher the received message, and similar devices could be added to other typewriters without necessitating the adoption of separate keyboards, which would likewise solve the problem, but in a less simple way. Zehnder would also use horizontal antennæ with terminals' dipping into the sea, on board ship; considering the length of modern ships, waves of sufficient lengths would be applicable.

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**The Number of Animal Species.**—In view of the avalanche-like growth in the number of animal and vegetable species known to biologists, it has been proposed by Shipley that museums should be reorganized, all specimens of certain species being concentrated in one museum and exchanges being made from the existing collections so as to bring about this result. While such an arrangement has obvious advantages, it is hardly likely to be carried out in the near future, inasmuch as it would be extremely difficult to persuade all the authorities concerned to acquiesce and be prepared to make the necessary sacrifices. There are, of course, also other disadvantages which occur to one, for instance, the fact that it would be impossible, under such a system, to consult any exhibits of certain species without making a journey to some distant museum. How serious the present situation is, however, may be judged from the following figures: About the middle of the nineteenth century there were discovered in the course of fifty-one years 238,000 new animal species. This represents a rate of about 5,000 a year. At the present time, the number of new species discovered and described each year is estimated at about 12,000, and this does not by any means represent all the specimens laid down in museums, since no one has time to completely investigate these. According to Dr. Sharp, there were, in 1895, 250,000 insect species known and described; that is to say, 30,000 more than had been noted fifteen years before by Guenther, who, at the time, expressed the opinion that the number of known insects represented only one-tenth of all the species.—*La Nature.*

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* Reprinted from *Engineering*.

[1] See *Verhandlungen der Deutschen Physikalischen Gesellschaft*, 1911, p. 876.

[2] *Elektrotechische Zeitschrift*, November 2nd, 1911, p. 1101.

# X-Ray and Ordinary Stereo-Photography Combined

## A Device by Which Internal Structures are Seen in Their Actual Location

A most interesting development in X-ray photography has, within the last week or two, been exhibited in this country by its inventor, Dr. P. H. Eijkman, chairman of the Netherlands Röntgen Ray Society. Dr. Eijkman's apparatus not only enables one to obtain stereoscopic pictures, in which all the features displayed appear in the proper space relation, but, what is most important for practical purposes, it is possible by its means to cause this stereoscopic image to appear in coincidence with the object itself. The significance of this for operative work hardly needs to be pointed out. The surgeon can view the part to be operated and actually see its internal structure, and place his scalpel almost as if he were dealing with a transparent object. To fully appreciate the importance and value of the new method it is almost necessary to see the apparatus at work. The stereoscopic effect is quite remarkable. When the object is withdrawn from its position, so that only the stereoscopic X-ray image is seen, a pointer held in the hand can be brought into coincidence with any particular feature of the image, and in this way one obtains a full realization of the three dimensional characters of this image, for a point is fixed not only as regards its position from right to left and forward and backward, but also up and down.

Dr. Eijkman's apparatus further provides for the preparation of an ordinary photograph strictly coincident with the X-ray photograph, so that a permanent record can be obtained of the aspect of the object when viewed with the stereoscopic X-ray apparatus. In addition to this the new instrument presents a number of most interesting and important detail features which will be referred to in the description which follows.

The process, briefly described, is as follows:

The first step is to prepare the X-ray photograph of the part to be recorded, this operation being carried out in the first place much as in any other instance, except that especial care is taken to exactly locate the X-ray tube and the window in front of it in a perfectly definite position. This exact adjustment is obtained by the aid of two small apertures which transmit a narrow beam of X-rays on each side. This beam is allowed to fall on a phosphorescent screen and the tube is moved until the two spots of light adjust themselves coincident with certain marks on the screen. When this is done one exposure is made, and the tube is then moved through an exactly predetermined distance, corresponding to the distance between the pupils of the observer's eyes. A second exposure is then made, under exactly the same conditions as the first, and maintaining exactly the same length of exposure. The plates are then developed, and if desired they may immediately be placed in the viewing apparatus to be described below, and the part previously photographed may then be viewed. If preferred, or if circumstances demand it, the patient may be withdrawn from the apparatus and brought to it again later, in which case the part treated must be brought into the same position in which it lay during the preparation of the X-ray photographs.

The mode of operation of the apparatus employed for viewing the stereoscopic X-ray photograph, either with or without the presence of the coinciding object, is shown in our diagram. We shall here describe it as if the object were placed in the apparatus, so that the object and the X-ray image are seen coinciding. The reader will, of course, understand that if the object is not present the stereoscopic X-ray image is seen alone in relief. The eyes are located at $R$ and $L$ whence they view the object placed at $P$. At $M^3$ and $L^3$ are placed the X-ray photographic transparencies illuminated by a bright light, such as that of a window. At $S_r^1$ and $S_l^1$ are placed two transparent mirrors forming an angle of 45 degrees with the line of sight of the eyes and at an angle of 90 degrees with each other. At $S_r^3$ and $S_l^3$ are placed two fully silvered mirrors in the position as indicated. When the apparatus is in use the eyes view on the one hand the object $P$ through the transparent mirrors, and on the other hand by reflection at the opaque mirrors the X-ray plates $M^3$ and $L^3$. All adjustments in the course of operations are precisely calculated so that the images produced coincide exactly in space.

Fig. 1.—The Inventor and His Apparatus.

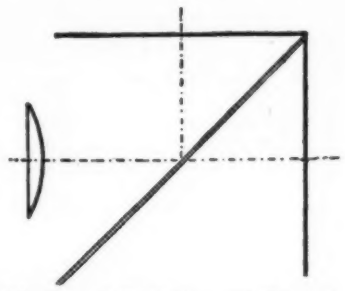

Fig. 2.—Diagram of the Instrument Shown in Fig. 6.

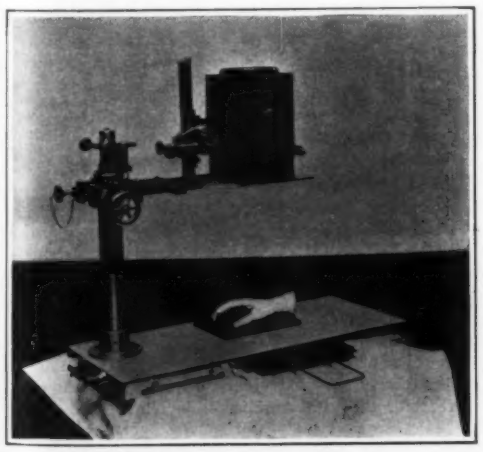

Fig. 3.—The X-Ray Tube in Position.

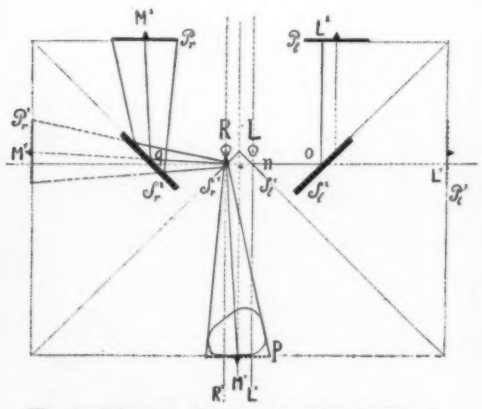


Fig. 4.—Diagram of Apparatus Seen in Fig. 5.

Fig. 5.—Viewing Object and X-Ray Image Together.

If it is desired to retain a permanent record of the appearance thus presented by the object and its X-ray stereoscopic image, an ordinary photograph of the object is taken by placing a camera at the position occupied by the eyes in the diagram above, and subsequently preparing reduced copies of the X-ray photographs, bringing them down to exactly the same scale as the photograph of the object. The stereoscopic photograph and X-ray picture are then viewed together in an apparatus whose construction is diagrammatically illustrated in Fig. 2. It simply consists of a transparent mirror contained within a box and making an angle of 45 degrees with its sides. At one of these sides is placed the stereoscopic X-ray picture and at the other the ordinary stereoscopic view. The eye sees one of these by direct vision, through the transparent mirror, and the other by reflection by this mirror, the images being made to coincide exactly.

There are a number of minor features in Dr. Eijkman's apparatus which are really of greater importance than may at first sight appear. For instance, there is an automatic arrangement whereby each exposure is numbered and the position of certain points indicated on the plate. As Dr. Eijkman remarked, a physician performing an operation must have all unnecessary matters of detail taken off his mind, and it is quite essential that these little points should be attended to by automatic means.

An amusing feature is the arrangement of a certain screw head, which is used for making some of these adjustments. When not in use this screw head is placed on an idle axle, as Dr. Eijkman remarked, to protect the physician against his friends who, on viewing the apparatus, are almost sure to turn the screw and destroy the adjustment. Any one who has had occasion to work in a laboratory knows how almost irresistible is the temptation, especially among laymen, to touch apparatus and handle it, and turn any conspicuous screws or taps which may be at hand, and while Dr. Eijkman's precaution may appear somewhat humorous, as a matter of fact it is very necessary.

Fig. 6.—Tilting Shows One Image or the Other or Both.

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**The Disinfecting Action of Soap.**—In the popular mind soap has come to be regarded as a possible vehicle for disinfectants, but the disinfecting power of the soap itself is not ordinarily properly appreciated. Thus, for instance, soap is superior to coal tar preparations in this respect. A bed bug is killed by a one-minute immersion in a 1 per cent soap solution, while to obtain the same result with a coal tar solution, it must be used one and one-half times to twice as strong. On the other hand, in order that soap may exert its germicidal action it requires the addition of an alkali or an antiseptic. Furthermore, in many cases, soap, in conjunction with some antiseptic, exerts an action quite out of proportion with its simple direct effect. Thus, for example, a mixture of equal parts of carbolic acid and soap diluted with seventy-five volumes of water has the same germicidal effect as a solution of carbolic acid in one hundred parts of water alone. In the soap solution, the carbolic acid is diluted one hundred and fifty times, so that the addition of soap has increased its activity by fifty per cent.—*Die Welt der Technik.*

# The Self-starting Syphon

## Its Principle and Construction

By Wm. P. Munger

If a straight glass or other tube be plunged vertically into water with the top end of the tube closed, and the bottom end open, when the stopper is suddenly withdrawn from the top, the water will rapidly rise in the tube. This inrush does not cease when the water reaches the level of the water on the outside of the tube, but continues till the water reaches a certain distance above the outside water level. The water level then oscillates with decreasing amplitude till the water comes to rest in the tube at the level of the water outside the tube. This effect may be very easily studied with some straight glass tubes and a vessel of water as shown diagrammatically in Fig. 1. Hold the finger over the upper end of the tube, and plunge it vertically to a known depth in the water, then remove the finger and note the height to which the water rises.

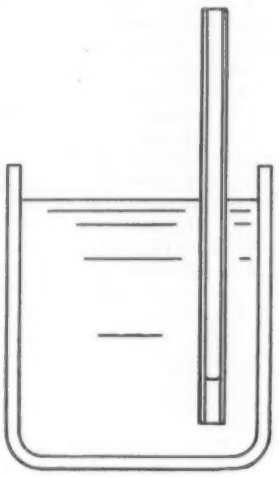

Fig. 1.

From a number of experiments conducted with tubes up to 6 feet long and 1½ inches in diameter, the writer drew the following conclusions:

1. For an immersion of less than 2½ decimeters the lift (due to inertia) is approximately 50 per cent of the immersion. For greater depths of immersion the percentage of lift gradually decreases.

2. When allowance is made for capillarity the percentage of lift is nearly independent of the size of tube employed. As the area becomes greater in proportion to the perimeter, the lift for a given immersion becomes greater owing to proportionally decreased surface friction on the side of the tube.

3. The percentage of lift varies for a given bore, and a given immersion, with the smoothness of the internal surface of the tube.

By bending a tube to the form shown in Fig. 2, filling the tube with water and putting one end into a vessel of water, a syphon is formed, which will deliver fluid as long as fluid is supplied to the inner tube, and the external fluid level is lower than the internal fluid level. If instead of filling the tube with water, the operator places his finger or other stopper on the outer end of the tube, and places the tube in position as shown diagrammatically in Fig. 2, when the finger or stopper is suddenly removed, the inertia effect described above would cause the water to rush up into the bend, and if, when measured along the middle of the tube, the distance from the water level over the bend and down to just below the water level produced (*B* in the figure) was not more than the lift obtained in a straight tube for the same immersion, the water would continue to come down the outer tube and the syphon would continue in operation till the water was exhausted or the level of the water on the outside became equal to that on the inside.

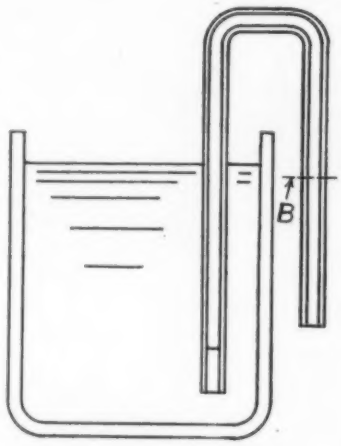


Fig. 2.

If additional bends are put in the inner end of the tube as shown diagrammatically in Fig. 3, a syphon such as was exhibited in Munich two years ago, and recently described by an American writer will be formed. When a tube of this form is immersed in water, the internal water level will be maintained in the limb *D-E* till the tube is lowered so that the water will run over the bend *D*. At once the water will run down to *C* and, owing to inertia, over the bend to *B*, and then discharge at *A*. There is in addition to the inertia effect previously described, some force generated by the water falling from *D* to *C*, but that is largely used up in overcoming the increased friction of the system. By putting additional bends similar to *C D E* onto *E*, the effective lift might be increased a little. Whenever the tube is withdrawn from the liquid, liquid will collect in bend *C*, and so prevent the syphon from starting, when again immersed in a liquid. To overcome this objection the writer has devised a self-starting syphon operating on a different principle, and shown diagrammatically in Fig. 4. The device consists of a tube bent to form a syphon tube and having a small hole *A* a little way from the end of the inner limb. Over the end of the inner limb a cylindrical cup having the lower end open is fitted, so that the upper (closed) end of the cup is fastened to the syphon tube just above the hole *A*. When immersed, the water in attempting to fill the cup, compresses the air in the cup, which then forms a reservoir of compressed air for actuating the device. Now, when the limb is plunged into the water, the outer end being open, the inner limb will fill with water as previously explained and the cup with compressed air, the compressed air will escape through the aperture *A* into the tube, thereby forming a column of water mixed with air bubbles. This column is lighter than the surrounding water, so the surrounding water having egress through end of the tube *T* will endeavor to equalize the density, and thereby push the lighter column ahead of it. This action would continue till the balance was established. If the apparatus is properly proportioned the tube will become filled with a mixture of water and air and as the fluid passes level *B* the syphon will start. When the air becomes exhausted, the water will follow the path of the air and water up to at least the external water level owing to the external water pressure, then the weight of the column of water and air in the outer limb, in trying to run out the end of the tube, will create a partial vacuum behind it, and the external air pressure will force the water into the partial vacuum. This action will continue till the tube above the water level is filled with water, and the level of the water in the external limb is a little lower than the water in the jar. The critical point will then be passed, and the syphon will be started.

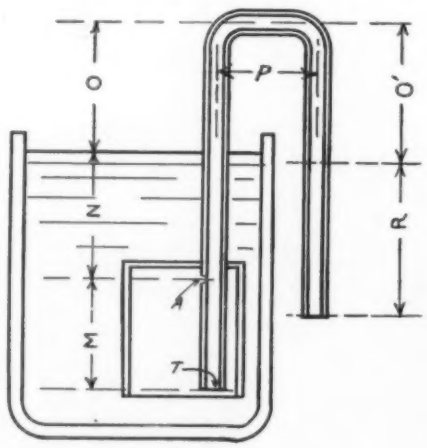


Fig. 4.

For this device there are of course limiting proportions. The proportions so far developed are:

*O* should not be greater than *N*.

Initially *R* must be greater than *O*.

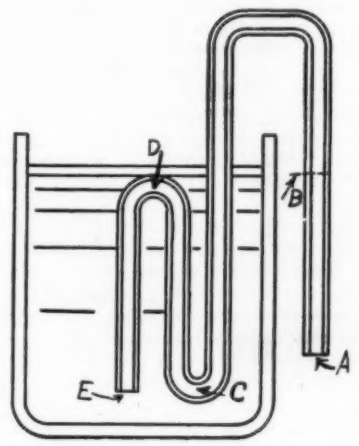


Fig. 3.

The aperture *A* must be of such a size that the mixture of air and water in the tube is about in equal proportions (this would vary with varying depth of immersion).

The air cup need not have more than one and one-third the capacity of the tube.

The advantages of this type of self-starting syphon are:

It is self-clearing.

One hundred per cent or more lift.

It is simplicity itself.

It is easily cleaned.

The air chamber can be made flat, short, long or otherwise to suit the opening through which it must pass, as bottle necks or storage batteries.

### Natural Selection in Man.

Mr. E. C. Snow, in his paper entitled "The Intensity of Natural Selection in Man" (Drapers' Company Research Memoirs, Studies in National Deterioration, No. vii. London: Dulau & Co., 1911), has set himself to answer the following question: Has heavy infantile mortality any selective value or tendency to eliminate the more sickly and to spare the hardier children? Of the data available for the investigation of this problem, the most satisfactory are derived from the annual volumes of Prussian statistics, and the most definite of the results were obtained from them. In order to indicate the method employed, one example will be described. Thirty rural districts in Prussia were taken, and all the children in them born in the year 1881 were considered. It was ascertained for each district how many of these children died in the first two years of life and how many in the next eight. Now, it is obvious that if the infantile mortality tends to weed out the weaker children, then in those districts in which the mortality among the children born in 1881 was highest in the years 1881 and 1882 it should tend to be lowest in the years 1883-90, since stronger children less likely to succumb to the ailments of childhood would have survived their first two years. In other words, there will be a *negative* correlation between the number of deaths in the first two years of life and the number in the next eight, provided that allowance is made for the total number of births in each district for the year 1881 and for the effects of environment. After making these necessary allowances by means of the formula for partial correlation, a coefficient of —0.93 was obtained in the case of males and of —0.85 in the case of females.

These results, considered by themselves, would seem to show that the selective action of infantile mortality was very strongly marked; but it is perhaps unnecessary to say that the author, whose work bears every sign of the most painstaking care and thoroughness, has brought forward a considerable body of additional evidence derived from data of a similar nature collected both in England and Germany. The greater part of it corroborates the conclusion stated above, though the correlation coefficients were in no other cases found to be so high, and in some cases the sign was actually positive. Yet we are of opinion that, on the whole, the author is justified in saying: "Natural selection in the form of a selective death-rate is strongly operative in man in the earlier years of life."—*Nature*.

# Auxiliary Player for Reed Instruments

## "Artificial Wind" for Musicians

HITHERTO there have been essentially two kinds of wind instruments in use. On the one hand, those blown directly from the mouth, in which the performer himself supplies the wind, with the expenditure of a corresponding amount of energy and with the consequent

Musician Using the "Aerophor."

limitations, such as the necessity of taking a breath at intervals. On the other hand, there are instruments of the type of the pipe organ, in which the wind is provided by mechanical means, either by a separate operator, or, in the case of small instruments, by the player himself, who works a foot bellows.

A German inventor, Court Musician Bernard Samuels, has recently given to the musical world a new resource, by a device which he calls the "aerophor," and which is designed to supplement the wind of a performer playing by mouth on such reed instruments as the clarionet, the oboe, etc. The device is in some ways unique, the wind being blown into the mouth of the player before it is sent into the instrument. Our illustrations, which are taken from the German periodical *Die Umschau*, show the apparatus in use, and the diagram at the center displays the arrangement of the mouthpiece in its relation to the player's mouth.

As a matter of fact, the player of a reed instrument is at a severe disadvantage as compared with other

The Course of the Wind Through the Instrument.

instruments. The performance requires quite a considerable effort of the breathing organs, which, especially in the case of older players, becomes quite a hardship. As a matter of fact, no player of a wind instrument can possibly practice as much as players of other instruments. Another disadvantage, as indicated above, is that it is quite impossible to give an indefinitely sustained note. Occasional pauses must be made to take breath. This has been rather severely felt in the composition of chamber music especially, in which reed instruments cannot be very successfully employed. These disadvantages are all removed by the new apparatus, which consists of a tube ending in a mouth piece, and connected to a foot bellows, which serves to carry air from the bellows to the player's mouth. The player can take breath at will while performing, with the same ease as if he were not playing at all. Whenever he wishes to take breath, he simply draws an additional supply of air from the bellows. Thus it is possible to produce an indefinitely sustained note or a succession of such notes without difficulty.

The bellows is provided with a check valve, to prevent air from the lungs being blown into the bellows. In the normal position, the bellows is placed near the player's chair and is worked by the foot. Evidently, another advantage gained is that a very much

The Mouthpiece.

louder note can be produced than by the unaided breath. The air is driven from the bellows through the tube into the cavity of the mouth and is despatched from here into the instrument, in the same way as air from the lungs. It might be thought that the effect of blowing air into the mouth would be to inflate the lungs, but as a matter of fact this is not the case, owing to the closure of the glottis in the act of blowing. It hardly needs to be pointed out that a number of hitherto impossible musical effects can be secured in this manner. Many a passage in Wagner's and other operas, which hitherto could be played only by an extreme effort, are now rendered without any trouble. Notwithstanding all this, the new apparatus produces its effect without any undesirable secondary results, so that the hearer remains quite unconscious of the mechanical assistance of which the player is making use, except possibly in so far as the playing is unusually perfect.

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### The Menz Wheel—An Automobile Wheel With a Removable Felly

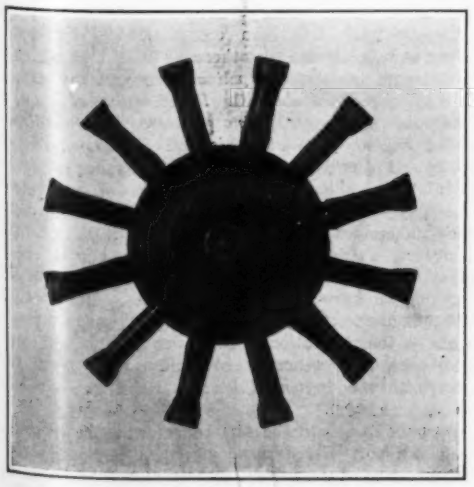
THE drawbacks of stationary fellies are well known to the automobilist. In the event of an accident occurring to a wheel in the open field, far from any human dwellings, his patience is bound to be taxed to the utmost by the annoyance of waiting in bad weather, until the driver after an hour or so succeeds in getting the wheel into something like working order, though this hasty operation only too frequently gives rise to a recurrence of the same trouble.

The auxiliary wheels that have been designed of late years can at most be considered as expedients for traveling to the nearest station, being too weak to withstand the strain of prolonged traveling, while exerting an injurious lever effect on the axle-journal.

These drawbacks are obviated by the Menz wheel designed by Herman Schunig of Vienna. This wheel in fact comprises removable fellies and allows the motor car to continue its course within five minutes of the occurrence of a defect, each felly (together with the defective rim) being replaced within 3 minutes by a reserve felly fitted with a pumped-up pneumatic tire. While avoiding uncalled-for delay, the use of these wheels thus affords considerable economical advantages by allowing the tires to be exchanged in the case of any sudden change in weather.

The Menz wheel consists of a wooden star of spokes held only by the nave, on which an ordinary automobile felly is fixed. The free ends of the spokes carry coupling plates, comprising a stationary and a removable flange for fixing the felly. As the loose flange is tightened, the action of its slanting surfaces on the rings of the felly stretches the latter in a radial direction, while compressing radially the spoke system and thus imparting to the wheel remarkable elasticity and solidity. This arrangement avoids the use of double spokes hitherto found necessary for spoke systems with removable fellies.

Since there is no need of any special means for securing the felly beyond the very light coupling plates, and a wooden rim is dispensed with, the use of Menz wheels entails practically no surplus load to be carried on board the automobile. The wheel is, owing to its structure, exceedingly light, and as the felly is free over its entire circumference, it is continually exposed to a draught of cooling air.



The Spokes.

Replacing a Defective Tire.

The Rim.

# Life Without Oxygen—I*

## The Anaerobic Beginnings of Life

By Carl Snyder

IT has been suggested that the beginnings of life must have been in the absence of uncombined oxygen, that is, in Pasteur's phrase, anaerobic. At least five or six convergent lines of evidence lead to this unexpected conclusion. These are:

1. That what appear to be the simplest forms of life are anaerobic still and that the majority of lower organisms, both plant and animal, can live under anaerobic conditions more or less continuously.

2. That the fundamental chemical processes of the cell in all organisms, even the highest, are anaerobic, phenomena of oxidation being of secondary or ulterior importance.

3. That the relations of anaerobic and aerobic life are genetic and that we have clear evidence of the gradual evolution of the latter from the former, an increasing need of oxygen accompanying an increasing complexity of chemical and morphological organization.

4. That this increase in need of oxygen as complexity increases is paralleled in the growth of the individual organism, the ability to endure complete abstraction of oxygen varying inversely with age and size.

5. That the oxygen of the atmosphere appears to have been formed exclusively by plant action. In the beginning there was probably no oxygen free: if there had been any, it would have been very quickly absorbed by the unoxidized substances of the earth's crust or the quantity would have been so small as to be practically negligible.

*The Facts of Anaerobiosis.*—So incessant and so absolute is the need of oxygen by the human organism and by animal organisms in general, that in the half-century following the momentous work of Lavoisier the belief in oxidation or "combustion" as a primary process of life came to be an *idée fixe* among physiologists, in spite of the fact that Spallanzani, who was almost contemporary with Lavoisier, had shown that infusorial animalcules can thrive when the supply of oxygen is reduced to a minimum (Spallanzani operated with air pressures of from one to three inches) and that the production of carbonic acid gas continues, in some cases without diminution, when the supply of oxygen is entirely cut off.

But everyday familiar experience proved too strong and so it was that the proof came as a shock when the existence of beings was established which not only did not need oxygen but to which the slightest trace of oxygen is as fatal as lack of it is to us. Had the discovery been announced with anything less than the preponderant authority of Pasteur it must have long remained unrecognized. Pasteur's first communication was published in 1861 and was entitled: "Animalcules infusoires vivant sans gaz oxygène libre et determinant des fermentations." In a footnote he remarks: "I propose, with all reserve, these new words, *aerobies* and *anaerobies*, to indicate the existence of two classes of primitive beings, one incapable of living save in the presence of oxygen; the other able to multiply indefinitely without contact with this gas."

During the half-century that has followed this announcement, this capacity of existing, for a time at least, in the complete absence of uncombined oxygen—facultative anaerobiosis—has been shown to be of wide occurrence in both the plant and animal kingdoms. On the other hand, the possibility of complete and unconditional anaerobic existence has been repeatedly denied; needless to say, it is one of the most difficult things in the world to establish the absence of oxygen. Thus Beijerinck was able to show that, in the case of certain forms supposedly anaerobic, for example the butyric acid ferments, the minutest trace of oxygen sufficed during a long series of generations. Beijerinck, therefore, proposed to divide living organisms into two classes—those which thrive best when the oxygen tension is at a maximum and those which thrive best when it is at a very low tension. The former he called aerophile, the latter microaerophile. This conception seemed to fit the facts so well that it was generally accepted for a time by the most careful observers, among them Fermi, A. Fischer, Chudiakow and others. But the discovery and investigation of the light-producing or photo-bacteria revealed a test for the presence of oxygen of such sensitiveness as to disclose the most minute trace. With the aid of this last and the development of a technique of quite extraordinary refinement, it has been possible, notably through the researches of Omelianski, Burri and latterly by the decisive work of Kürsteiner, to establish the correctness of Pasteur's early observations.

To those to whom the law of continuity or curve of probabilities is a constant mental companion, this final demonstration seemed a foregone conclusion. The fact that in passing from organisms like the higher animals to which a constant supply of oxygen is a necessity, every gradation in the need of oxygen was to be met with down to a point at which the utmost refinement of technique was required to discover that it was of use at all, left little reasonable doubt in the philosophic mind that beyond this point the absolute anaerobe must exist.

Why, now, should we regard these anaerobic bacteria as the lowest, the most primitive and, therefore, in all probability, the earliest of all living organisms known? For very much the same reason that we speak of the plant as "lower" in the scale of life than the animal. In general, at least, the higher types of animals are able to exist only by means of preformed organic products. The plant is able to derive its food directly from the soil and the air. It is evident, therefore, that a great land flora must have preceded any notable development of a land fauna.

Further, it is known that prior to the development of an extensive land flora there must come a great bacterial population, both to form and to prepare the soil. This is evident from what happened after the Krakatoa explosion in 1884. So far then as life on land is concerned, an extremely primitive microscopic life is apparently antecedent to all other forms.

The same is true of the sea. In recent work, A. Pütter has endeavored to show that the floral and primitively synthetic organisms of the sea are quite inadequate to support the astounding abundance of life which, little by little, we are coming to learn exists there—a volume so great that compared with it the total amount of land and aerial life is an almost negligible quantity. Pütter, therefore, endeavors to show that the sea is a vast, though very weak, organic solution. His results have not been confirmed and have even been directly called in question, though on the face of the evidence some such conception as his seems to be necessary to many. But whether or no the destructive metabolism of the sea be less complete than that on the land, it is still obvious that a vast floral life, directly utilizing solar energy, is a condition of a development of oceanic animal life such as we know exists; such a flora is found in the Plankton. It is evident that the algæ, the desmids and their like must have preceded, in point of time, the more elaborate animal types. Side by side with these is to be found in sea water the same teeming bacterial life as in the soil; moreover, for the most part, marine bacteria are of the same types and varieties as soil bacteria.

It is amid these prototypes of life, both in the sea and in the soil, that the anaerobic bacteria are found. Like all bacteria and the most primitive types in general, they are neither plant nor animal in any clear sense of the word. Some, like the plants, derive their nutrition directly from inorganic materials; others live on the dead organic substance of plants and animals; while others are able to exist only as parasites, inhabiting the tissues or cavities of living organisms. Finally, some live now in the one way, now in the other. They contain no chlorophyll; they need no sunlight. Some are fixed but others are free swimming organisms. But whereas only a few of the bacteria and practically none of the plant forms—the case of the Schizophyceæ is still rather doubtful—are able to assimilate gaseous nitrogen, it is among the anaerobic bacteria that the most typical nitrogen fixers are found.

Consider the implication. The anaerobic organism is evidence of the fact that gaseous oxygen is not essential to the synthetic changes which accompany life. It is only as we rise in the scale of life that the need of oxygen becomes obvious. On the other hand, the capacity of assimilating nitrogen exists only in the lowest forms and as we ascend the scale is very quickly lost. Considering how essential the element nitrogen is in the chemistry of life and the established non-essential character of gaseous oxygen, we seem driven to the conclusion that the most primitive and therefore the earliest form must have been a nitrogen fixer to which a supply of uncombined oxygen was immaterial.

It is true that *Bacterium clostridium* (Past.), the best studied of the organisms that assimilate nitrogen, requires for its nutrition a supply of glucose, that is to say an organic product; while forms are known, like Nostoc, among the Schizophyceæ, which are able to fix at least minor quantities of nitrogen in an entirely inorganic culture medium, that is to say they do not require a ready-made supply of complex organic carbon compounds. It is for this reason that the Nostoceæ have been regarded by some as the more primitive form. Euler observes:

"We have herewith every reason to seek among the Schizophyceæ the earliest inhabitants of the earth. Further support for this assumption is derived from repeated observations that these algæ are always the first colonists on sand, bare and humus soil and the like. A celebrated example is that afforded by the Nostoceæ, which Treub found as the earliest germinants on the sterile soil of Krakatoa, after the famous catastrophe."

But the ability to assimilate carbon from its simplest inorganic compounds, the carbonates, not only from carbon dioxide but even from the deadly monoxide, is shared by many absolute anaerobes, even though it is not by *Bacterium pas[illegible] anum*. Nostoc is apparently better able to propagate rapidly under the atmospheric conditions which now prevail but as we shall see it is at least extremely doubtful if these same conditions obtained in the earlier epochs of the earth's history.

The conclusion that the anaerobic nitrifiers constitute the more primitive form is supported by the behavior of these and other low forms toward an oxygen supply. It is now a well-established fact that many, if not all, of the incontestably anaerobic bacteria may, under suitable conditions, be cultivated and reproduce rapidly under ordinary atmospheric conditions. On the other hand, some at least of the supposedly absolute aerobes, as Rosenthal, Tarozzi and others have shown, if passed through a series of cultures in which the supply of oxygen is more and more attenuated, may at last be cultivated freely under completely anaerobic conditions. In the ancient phrase they may be "adapted" to an anaerobic life.

It has long been known that there are intermediate forms which are indifferently oxygen users or abstainers, according as this element is present or absent; in other words, the oxygen habit is apparently one which may be readily assumed and readily put aside. On the other hand, there does not seem to be any clear evidence that a corresponding nitrogen habit may be acquired where it is non-existent. The ability to assimilate uncombined nitrogen seems to be an extremely primitive faculty, quickly put aside and finally lost as the complexity of the organism increases.

In the light of this conclusion and the fact that complete and enduring anaerobiosis is to be found only among the more primitive forms, it seems almost impossible to regard the faculty of living without oxygen as an "acquirement." We shall have decisive proof in the sequel that it is not. It is the ability to use uncombined oxygen which is the "acquirement;" and we seem, therefore, driven to the conclusion that the anaerobic was the more primitive and the earlier form.

What is true of the bacteria is equally true of the protozoa. Thus Bunge has shown that many of the more primitive forms are either actively or conditionally anaerobic to a very considerable degree. Vinegar eels (*Anguillula aceti*) lived and displayed the liveliest sort of motions in complete absence of oxygen during seven days, leeches during three days, Ascaris five days, Hæmoptis two days, Clepsina six days, Nephillis two days, snails ten to fifteen hours, etc. Apparently the observations were carried out at room temperature; Pflueger, however, has shown that the ability of the frog to resist the withdrawal of oxygen is inversely proportional to the temperature, so that it is probable that at the ordinary temperatures at which many of the slime worms live their need of oxygen is still less than Bunge's observations would lead us to suppose is the case.

Bunge's work has been continued by Weinland, Pütter and Lesser among others. Pütter kept leeches alive during ten days; *Opalina* during twenty days; he also experimented with *Paramæcium caudatum*, *Colpidium colpoda*, *Opalina ranarum*, *Balantidium eozoon*, *Nyctotheris caudiformis* and *Spirostomum ambiguum*. Pütter's conclusions were as follows:

"In their widespread independence of molecular (free) oxygen and in the dependence of the faculty of living anaerobically on the state of nutrition and the supply of nutriment, the protozoa present a close agreement with countless plants, while in the animal kingdom we have as yet few analogies. But this is doubtless due to the fact that we have as yet few experiments on the respiration of the lower animals and that these even have generally been interpreted so as to agree with the dogma of the invariable necessity of molecular oxygen."

Duclaux speaks to the same effect when he remarks upon the part which pure *suggestion* has played in the formation of the ancient (but still largely dominant) theories of respiration.

* Reprinted from *Science Progress*.

*The Fundamentally Anaerobic Character of the Vital Process.*—The first wide breach in the ancient dogma that oxygen played an essential part in vital metabolism came from the researches of Pasteur; his work was the first which distinctly showed that the vital process was to be correlated with the process of fermentation. It was he, indeed, who defined fermentation as "life without air," that is without oxygen as such. It is among the further ironies that though the long strife between the followers of Pasteur and the followers of Liebig, over the chemical nature of fermentation, was ended finally and decisively in 1897 by Buchner's epoch-making discovery of zymase, most biologists still cling implicitly to Pasteur's ideas of life in spite of the proof that Pasteur himself supplied that life and fermentation are one and the same thing.

Pasteur showed that in the case of certain of the lower organisms the life process could be carried on in the absence of oxygen. But the generalization of this fact, that anaerobiosis is fundamentally true of the vital processes in all organisms, was first clearly set forth, apparently, by Hoppe-Seyler. This conclusion was implied in the work of Spallanzani and indeed was distinctly stated by him in the latter part of the eighteenth century. This amazingly fertile and pioneering man had studied the production of carbonic acid in the case of living and dead snails "in azotic (nitrogen) and hydrogen gas and in common air." Summing up, he said:

"I shall only conclude from these experiments that it is clearly proved that the carbonic acid gas produced by living and dead snails in common air did not result from the atmospheric oxygen, since an equal and even greater quantity was obtained in azotic and hydrogen gas."

Spallanzani was a full three-quarters of a century ahead of his time. It is instances like this that serve to remind us at times of the large amount of clear-sighted work which remains unrecognized.

Hoppe-Seyler's investigations were formulated in the first volume of his *Physiological Chemistry*, published in 1877. His cautious conclusion was stated in the following words:

"Although the putrefactive processes have been set forth in complete parallel to the phenomena of life, it should not be understood thereby that the two are identical, only that any difference is as yet unknown."

Hoppe-Seyler based his view of the fermentative nature of respiration on the following facts:

1. In the animal organism, reduced substances such as urobilin, succinic acid, hippuric acid and so forth result from the introduction of quinolinic acid and the like and appear in the urine in company with unquestionable products of oxidation.

2. Many easily oxidizable substances may pass through the organism unoxidized.

3 Between the production of carbon dioxide and the consumption of oxygen there is no constant relation.

4. Although ozone is not and can not be demonstrated in the organism, nevertheless a complete destruction of complicated organic compounds to carbon dioxide and water takes place, while we are able to bring about these same oxidations outside the body only very slowly and incompletely even with the aid of the strongest oxidizing materials.

Similar ideas were independently advanced and the anaerobic nature of the fundamental chemical changes in the cell still more definitely insisted upon by A. Gautier. His ideas are summed up in his admirable little *Chimie de la Cellule Vivante* (2nd edition, Paris, 1898). After describing his experiments, he concludes:

"Anaerobic life which up till then had been thought to be characteristic only of certain primitive microorganisms, in particular of the schizomycetes, is the essential and fundamental mode in which most protoplasm functions. This view is founded on three orders of proof. First, that the animal organism produces a number of reduced substances, among others the ptomaines and leucomaines, that I had just discovered; second, that in the humours of the economy are found the identical substances that I had shown are formed in the course of bacterial decomposition of the albumens, lactic acid, different fatty acids, amidatid compounds, phenols, carbonic acid and ammonia; third, that the quantity of oxygen found in the totality of our excretions exceeds by about one-fifth the quantity of oxygen taken from the inspired air" (p. 99).

Meanwhile, in 1875, Pflueger had repeated Spallanzani's experiments on frogs and confirmed the fact that when put into a vacuum they continue to give off carbonic acid. A little later the same phenomenon was observed by Pfeffer in plants. Pflueger gave to this process the term "intra-molecular respiration." "So firmly had the conception of combustion been impressed upon physiologists that when this anaerobic respiration came to be explained, it was supposed that certain molecules of organic matter within the cell gave up their oxygen to others that they might thus be burned in the body furnace to yield energy."

The name, however, was but a mask for mystery. Thanks to the work of the physiological botanists and especially to E. Godlewski, to W. Palladin and their respective schools, to Kostytschew, Stoklasa, Mazé and others, the matter has now been cleared up. In the absence of oxygen, the respiration of plants we may surmise, as that of animals also, for the most part is a process strictly comparable with alcoholic fermentation. In order to exclude the intervention of any mystic "vital agencies" Palladin conducted his experiments upon plants killed by freezing. But latterly Kostytschew has been able to show a case of anaerobic respiration in the living plant in which there is no simultaneous production of alcohol. If *Agaricus campestris* be cultivated under aseptic and anaerobic conditions, no alcohol is formed; moreover an increased supply of sugar brought no increase in the production of carbon dioxide.

An endeavor to identify respiration as essentially a process of hydroxylation has been made by A. P. Matthews and by Barnes. In his paper on "The Nature of Protoplasmic Respiration and Growth," Matthews notes, among others, the following facts which must be explained by any adequate theory:

1. "Even though surrounded by oxygen all protoplasm maintains itself while alive in a reduced state and acts as an intense reducing agent. Its reducing powers are comparable with those of nascent hydrogen.

2. "For all forms of protoplasm oxygen above a certain tension is an intense poison. For some forms this tension may be no more than a very small fraction of an atmosphere; for others it is from three to four atmospheres.

3. "Atmospheric oxygen has little oxidizing power; whereas protoplasm brings about oxidation of the most radical nature and is comparable in its oxidizing powers to the most intense chemical oxidizing agents.

4. "Hydrogen is evolved as a gas by a great variety of bacteria and molds.

5. "Many forms of protoplasm such as the anaerobic bacteria are able to bring about intense oxidations in the absence of atmospheric oxygen."

Matthews adds:

"The studies of Armstrong, Dixon and others on the processes of slow and explosive oxidations and combustions throw, in my opinion, a remarkably clear light on protoplasmic respiration. These authors have shown that in ordinary oxidation the presence of some water is necessary to the oxidation. Phosphorus in a perfectly dry state will not ignite in dry air. Armstrong concludes that the primary oxidation in all these cases is not brought about by the gaseous oxygen but by the water. The atmospheric oxygen acts the part only of a depolarizer to take care of the nascent hydrogen formed from the water.

"The same hypothesis will explain protoplasmic respiration and at once makes clear the identity of anaerobic and aerobic respiration. The following theory of respiration is founded in part on Armstrong's work:

"The real respiration of all forms of protoplasm, both aerobic and anaerobic, is brought about not by the oxygen of the air but by that of the water. The hydrogen set free from the water combines with other elements of the protoplasm, thus keeping it reduced; it also combines with the oxygen of the air if this is present to form water; and in the absence of oxygen it may escape as free hydrogen.

"The only difference between anaerobic and aerobic respiration is that the anaerobic protoplasm is so powerful a reducing agent that it is able to drive hydrogen out of the water, thus oxidizing itself without the aid of atmospheric oxygen to act as a depolarizer."

Primarily then, in Matthews' view, "respiration is the dissociation of water accompanied by the liberation of hydrogen."

Practically the same view is sustained by Barnes from the botanical side. In view of the fact that the word "respiration" now connotes ideas no longer consistent with the facts, Barnes proposed the terms aerobic and anaerobic *energesis*, to which fermentative energesis might be added if necessary.

Still further proof that the characteristics of living protoplasm are those of a reducing agent have been brought forward by Loew and Bokorny in their well-known endeavor to establish a chemical difference between the living proteins and "dead proteins." The active or living protein behaves as an aldehyde and displays marked reducing powers. This latter capacity is not, according to these authors, displayed by dead protein.

Finally, as nearly conclusive proof that, in the plant at least, uncombined oxygen has little or nothing to do with respiration, it is to be noted that in plant respiration a direct relationship between the concentration of the oxygen and of the carbonic acid is directly demonstrable. In agreement with the law of mass action, a high concentration (four to eight per cent) markedly lowers the respiration rate.

On the other hand, any influence arising from a variation in the partial pressure in oxygen is extremely difficult to demonstrate. "Even in the higher plants," says Euler, "in which chemical differentiation has been carried to the farthest degree, a widespread indifference is to be found towards such a variation, so that in many species respiration continues without interruption even when the air contains only two per cent of oxygen (according to Stich) or indeed only one per cent (according to Johannsen). Equally indifferent are most plants towards a notable increase of the oxygen concentration, so that the latter may be increased by at least four or five times the normal amount without producing any effect. And as Bert has shown bacteria may endure simply enormous pressures."

To be continued

## Research

ONE of the latest additions to curricula of technical schools is research work. Research may be regarded as the marshal's baton which every student carries in his satchel; it represents the highest ambitions of the student's breast, and it is held to confer more honor than the university degree. To be a research scholar means to the student's mind to be engaged on new and original investigations, and it places him on the same platform as Faraday, Joule, Ohm, Boyle, and the scores of other great people who have discovered new laws and added new definitions to our dictionaries.

Of the educational value of research no one can be in doubt. Properly and honestly conducted, there is probably no higher training for the mind. It leads to great precision of thought and to much experimental dexterity. Moreover, though narrow in itself, it is but the opening to a large field, and in the pursuit of it the area of knowledge opens wider and wider. It calls out, too, all the student's powers of observation, the most useful of all the faculties he acquires in the laboratory. But when we have said all this for technical college research work we have summed up nearly all that can be righly claimed for it. Too often the student gets a wrong idea of the value of his research work. He forgets that its object is to train him, and that any other value it may have is, in ninety-nine cases out of a hundred, practically nil. Too often it is undertaken with the hope that it may bring honors rather than knowledge. The student imagines that he is doing something great for the world, and starting with an exaggerated opinion of his own importance, nourishes bitterness in his heart against those who estimate the value of his work by the accepted commercial standards. We should be the last to discourage the ardor of youth, but we venture to suggest that it would be better for his own happiness if his professors insisted constantly on the fact that college research work is only a form of training, and that its value, from any other point of view, is generally insignificant. When the student in the art school gives up drawing from the antique and begins to study from the life, he is in a parallel position to the student who leaves the ordinary cut-and-dried laboratory work on what he has trained his 'prentice hand, and takes up research work. But the art student never supposes he is making pictures, and he is careful enough, as a rule, not to let the world see what he does. He recognizes that he is only studying, only making preparation for pictures he may paint some day. The research student does not take this view; he believes that at great sacrifices on his part he is conferring a benefit on the world, and as soon as he has amassed a quantity of figures, he takes—alas too often with the encouragement of his professor—the first opportunity of rushing into print. It is there that he makes the mistake. "In most cases," said Prof. Marchant some time ago, "it is the carrying out of the work that is of the greatest value, and not the result. A great many papers are published not, mainly, in engineering subjects, of very problematical value." Now and then a student does do some really useful work, but as a rule the undeveloped state of the mind at college age and the limitations of the plant at his disposal render work that should be dignified with the name of research out of the question. Indeed, it is a pity that the work should be put to such a use. That we should pair, by applying to them the same name, an inquiry into the nature, cause, and prevention of, say, cancer and the leakage past the regulator valve of locomotive is absurd. All day long and every day engineers, chemists, physicists, etc., are engaged in testing, experimenting, and inquiring, but they look upon it as a bit of the daily routine, and do not exalt it by calling it research. The student replies, "Yes, they are doing it for business, I am doing it in the cause of science. They look for an immediate return; I am content to leave the return to chance." Precisely, the student who measures the resistance of ship-shape models in the college tank calls it research, while the men who are settling the forms of our battleships and merchantmen call it daily routine. But that is only a single example of what is happening in all directions. A youth makes a number of tests of different steels, and is honored with the name of research student, while another on 30 shillings a week is doing the same thing day after day with higher accuracy and equal intelligence, and is known as the works chemist.—*The Engineer.*

## Trade Notes and Formulæ

**Preventing Oxidation of Iron.**—The Cosslettizing process for producing a rust-proof finish on iron consists in boiling the article in a solution of 10 ounces of iron filings and 4 ounces of phosphoric acid in 1 gallon of water. The coating produced is black and if the work is carefully done, no undissolved iron filings will appear on the finished surface.—*Chem. Trade Journal.*

**Non-corrosive Alloy for Cans.**—According to A. Gudeman, an alloy containing as little as 0.5 per cent of gold, has been found which can be used to cover iron in cans to be used for food, and which is as resistant to corrosions as gold itself. Two ounces of gold in this form will cover a ton of iron and will cost twelve to fifteen times as much as tin plate. For canned food the extra expense is well worth while.

**Removing Paint from Bricks.**—If the paint is not too old, it may be removed by scrubbing it with a brush which is repeatedly dipped into turpentine, care being taken to work from the outside toward the center, to prevent enlargement by the spreading of the turpentine. A paste often used is made by dissolving caustic soda in five times its weight in water; the liquid is then mixed with one-fourth of its volume of oil and sufficient sawdust to make a paste. The latter is spread on the wall and scraped off after five or six hours. The wall is then well washed, to prevent it from becoming covered with a white scum.—*Brick and Pottery Trade Journal.*

**Coloring Picture Post Cards.**—The colors used for this purpose may be water colors or aniline dyes; and while the latter are more brilliant, they are not stable to light and readily fade. The surface of the print must first be painted over with a solution consisting of white of one egg, salt 4 grains, gum arabic 4 grains, quinine sulphate 2 grains, and water 2 ounces. The white of egg is beaten to a froth and allowed to stand for twelve hours; it is then filtered through clean linen, the salts added and finally the gum arabic and water. The solution is left on the card for two or three minutes, then blotted off with clean blotting paper. The colors are also mixed with a little of the above mixture. The chief point is—no matter what color is used—to avoid a deep tint, and it is far better to lay down two or three coats of the same color, than one thick one.—*Amat. Phot. and Phot. News.*

**Etching of Aluminium.**—According to *Technische Rundschau* a permanent writing on aluminium can only be obtained by etching. This may be accomplished either by treating the metal with caustic soda, resulting in dull lettering on bright ground, or by using an etching fluid giving black letters or designs. For the first mentioned method the aluminium has to be covered with a wax composition consisting of two parts of white wax, two parts mastic and one part of asphalt, melted together. The letters are scratched upon the surface with a tool, and the metal thus prepared is immersed into a solution of caustic soda. Here it is left until a lively effervescence sets in. To obtain black lettering, mark the aluminium with a rubber stamp or a stick of wood wetted with a solution of platinic chloride. A cheaper substitute is trichloride of antimony, to which has been added very little platinic chloride.

**Making Frosted Glass Clear.**—It is often necessary, in order to obtain increased light, to remove frosted glass from a window and replace it by clear glass. A correspondent in the London *Building World* recommends the following simple and inexpensive method of treating frosted glass to make it transparent. First clean the glass thoroughly with warm water and soap or methylated spirit, and then, when quite dry, procure a quantity of best transparent varnish, and evenly coat the surface all over. The varnish should be clear and free from lumps, and when applying care should be taken to remove all air bubbles and particles of dust. When this is done, it will be found that the glass is now almost perfectly transparent, and except for a certain waviness of surface, which is not of much consequence, it is as good as a pane of new clear glass. The reason for this transformation is fairly apparent. Previous to the glass being frosted, its surface was quite smooth and polished, but by abrasion, or the use of acids, the smooth surface was rubbed away and destroyed, leaving scratches and little projections which broke up and refracted light and vision. If the rough surface is covered with a smooth transparent coat of varnish, all the scratches and little crevices are filled up, leaving the surface of the glass as smooth as before it was frosted. Frosted glass may also be ornamented for trade signs, etc., or glass panelled doors, by painting any design upon it in varnish, and leaving the ground untouched, which has a very effective appearance. If at any time it is desired to remove the varnish, and refrost the glass, it is only necessary to thoroughly rub the surface with turpentine, until all traces of varnish have been removed.

## Science Notes.

**The Elasticity of Yarns** depends upon the staple, the evenness of the thread, the twist per inch, the percentage of size on the yarn and the hydroscopic moisture.—*Possell's Text. Jour.*

**A Masterpiece in Clockmaking.**—A cobbler of Strassburg, Germany, has recently finished a clock made entirely of straws. Even the works are made of straw. It has taken him nearly fifteen years to complete this odd clock.

**A Remarkable Coal Mine.**—What is perhaps the most extraordinary coal mine in the world may be found on a tiny island in the Japan Sea, near Nagasaki. This island has just sufficient room upon its surface for the shafts and the hoisting machinery. The workings, which are very extensive, reach out in all directions under the sea.—*Wide World Magazine.*

**The Invention of Spectacles.**—Roger Bacon knew lenses, and that they were useful for near vision in the old. For optical purposes, they appear to have been ground first about 1285 by a certain Salvino degli Armati, said to have died in 1317. A monk of Pisa, Alexander della Spina, who died in 1313, also has been accredited with the invention of spectacles and with the promotion of their use.—*John Hapk., Hosp. Bul.*

**New Asteroids.**—During the year 1911 fifty-eight small planets were discovered, but eight of these were found on examination to be identical with bodies previously observed, so that on balance there are fifty asteroids to be added to the family that circulate around the sun between Mars and Jupiter. Of these more than thirty were discovered at Heidelberg, the next largest contribution coming from the Transvaal Observatory at Johannesburgh.—*The Athenæum.*

**Prof. Volterra to Lecture at Paris.**—A course of lectures on integral equations and integral differential equations is listed at the University of Paris, to be delivered by the great authority on this subject, Prof. Vito Volterra. The subject of the first and last lectures are of general character, the first being on the subject of "The Evolution of the Fundamental Ideas of the Infinitesimal Calculus" and the last on "Some Applications of the Calculus to Phenomena of Heredity."

**The Only "Yearly" in the World.**—What is perhaps the only yearly newspaper in the world, the *Eskimo Bulletin*, is published during the month of May in Cape Prince of Wales. Civilization having been introduced by the first Europeans who settled there, a small printing press was ordered from the United States, and it was not long before the willing Eskimos were able to compose and print their own paper. If it is considered that these people until recently had no written language, this achievement is admirable indeed.—*Wide World Magazine.*

**Consumption of Horseflesh in France.**—The consumption of horseflesh in Paris appears to have increased rapidly from 1897 to 1907, when it reached the maximum; since then it has slowly decreased. From 1897 to 1900 the average annual consumption was 5,513,000 kilogrammes, from 1902 to 1906 it was 10,743,000 kilogrammes, in 1907 it amounted to 14,893,000 kilogrammes, in 1908 to 14,495,000 kilogrammes, in 1909 to 14,184,000 kilogrammes, and in 1910 it was 13,704,000 kilogrammes. Of the last amount (equal to 13,496 tons), 12,197 kilogrammes were furnished by animals slaughtered in Paris, and 1,507,000 kilogrammes were imported from other places. The total number of animals slaughtered in 1911 at the abattoir for horses in Paris was 49,403, being 48,070 horses, 870 asses, and 463 mules. The average yield of meat per head was 248 kilogrammes (542½ pounds).—*Journal Royal Soc. Arts.*

**Crumb and Crust.**—Lay discussion not infrequently turns upon the relative merits of the crust and crumb of bread, says *The Lancet*, and the matter is often referred to the family medical adviser as to which of the two is more digestible. Analysis shows very little difference in regard to the constituents of each, but the crust of course contains much less moisture, and so is richer in solid constituents. The crumb contains on an average of 43 per cent of moisture, while the crust contains only 20 per cent. One important dietetic difference between crust and crumb is the fact that the former contains an increased amount of soluble carbo-hydrates owing to the action of intense heat, which the crust receives, compared with the crumb during baking. Moreover the crust has a more pronounced "bready" flavor than the crumb, a flavor which is attractive and which stimulates the flow of digestive juices. That the digestion of crust in the mouth is much more likely to be complete than is the case with the crumb, everyone has generally found out for himself, as the placticity of the crumb and especially that of new bread, prevents to some extent the salivary attack. If new bread were as thoroughly masticated, as dry stale bread is bound to be, there would be no reason why it should be less digestible, but it seldom receives the necessary treatment in the mouth.

## Electrical Notes.

**Electricity in the Celluloid Industry.**—The necessary heat for forming the various articles composed of celluloid has usually been supplied by high pressure steam, and as the material becomes soft at a temperature of about 250 deg. Fahr., and ignites at about 30 degrees beyond that temperature, it is necessary to exercise a careful control over the heat. An electrical method is now being tried in which the heat is applied by hot plate elements. In the manufacture of celluloid combs, for example, the blanks are placed on the plate successively and are removed one by one by the workman as they are softened. Special heating elements have been constructed for this purpose, measuring 18 by 30 inches, and provided with quick starting connections, taking 450 and 900 watts, in order to heat the plate rapidly. The normal consumption amounts to about 225 watts.

**Photography in Japan.**—A little over half a century ago (1843) photography was among the innovations that came to Japan with the introduction of western civilization. Lord Mito was one of the first men of prominence to start investigations in photography. He sent Kikuchi, one of his retainers, to Nagasaki, where he learned of a Dutch book containing elementary instructions in photography and was able to secure it. Kikuchi had the book translated into Japanese, and having mastered the subject, returned to instruct the prince. Immediately the necessary outfit, camera, chemicals, etc., were ordered through the Dutch merchants in Nagasaki. They arrived and the art of photography was practised for the first time by Lord Mito himself. The progress and use of the art and its study were seriously retarded by the superstitious fear and dread with which it was regarded by the people, who thought it endangered their lives. Shemoaka Renja was the first in the field as a professional, and met with the greatest difficulties in pursuing his work. To gain the necessary knowledge of the art of photography he entered the service of the American envoy as a menial, as he had heard that the minister's interpreter was well equipped for taking photographs. The latter readily complied with his request for lessons in the principles of photography. Learning of the arrival in Yokohama of a real photographer from America, Shemoaka straightway left for the port to make his acquaintance. He succeeded in acquiring the photographer's complete equipment and opened his own studio to the public. But he had to depend entirely upon the patronage of foreigners, for no Japanese could be induced to go near such a place. At first things went well enough; but later he had great difficulties in replenishing the small laboratory, and worse still, was ignorant as to the preparations in which the chemicals must be used. His experiments resulted in utter failure, and he was about to abandon his beloved project, when a final trial brought success, to his great joy. Knowing he could find ready sale for pictures of the city, he placed his camera inside a palanquin, so that he could manipulate behind drawn curtains, as he did not dare to take the pictures openly. By having himself carried through the streets, he was able to obtain fifteen views—the first photographs of public places in Japan—which brought him large returns. In time the people learned to understand photography, and they became as enthusiastic in its favor as they had been against it previously, and photographers sprang up over the various cities.—*Japanese Magazine* condensed.

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